

CALIFORNIA DEPARTMENT OF TRANSPORTATION

2014 RAMP METERING ANNUAL REPORT

**District 7
Los Angeles and Ventura Counties**



Ramp Metering



Connector Metering

**STATE OF CALIFORNIA
Governor Edmund G. Brown Jr.**

**CALIFORNIA STATE TRANSPORTATION AGENCY
Secretary Brian P. Kelly**

**DEPARTMENT OF TRANSPORTATION
Director Malcolm Dougherty**



**DIVISION OF OPERATIONS
Office Of Traffic Engineering - North
Ramp Metering Branch**



2014

RAMP METERING ANNUAL REPORT

**DEPARTMENT OF TRANSPORTATION
DISTRICT 7**

Los Angeles and Ventura Counties

**CARRIE BOWEN, DISTRICT DIRECTOR
DISTRICT 7**

**ALI ZAGHARI, DEPUTY DISTRICT DIRECTOR
DIVISION OF OPERATIONS**

**ABDI SAGHAFI, OFFICE CHIEF
OFFICE OF TRAFFIC ENGINEERING - NORTH**

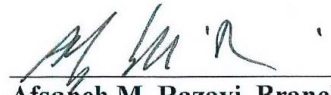
**AFSANEH RAZAVI, BRANCH CHIEF
RAMP METERING BRANCH**

2014 RAMP METERING ANNUAL REPORT

District 7

The 2014 Ramp Metering Annual Report has been prepared by the District 7 Office of Freeway Operations Ramp Metering Branch. The information in this report encompasses all of the work performed by the Ramp Metering Branch on the metered ramps and connectors in Los Angeles and Ventura Counties.

Prepared by:



Afsaneh M. Razavi, Branch Chief
Ramp Metering Branch



Approval Recommended by:



Abdi Saghafi, Office Chief
OFFICE OF TRAFFIC ENGINEERING - NORTH

Approved by:



Ali Zaghari, Deputy District Director
Division of Operations

ACKNOWLEDGEMENTS

Special thanks and recognition to the Ramp Metering Branch engineers for their assistance in the compilation of this report:

Allan Dumaplin

Behdad Sepanj

Bob Masatsugu

Fady Al-Awar

Hamid Kalkatechi

Iqbal A. Toorawa

Kazem Atefyekta

Nabil Eskander

Rafael Benitez-Lopez

Rody Torchin

Wahib G. Jreij

This report has been prepared by:

Jeff Le

TABLE OF CONTENTS

EXECUTIVE SUMMARY	1
A. SURVEILLANCE AND MONITORING OF RAMP OPERATION	3
Field Inspections of Ramp Meter Elements (Chart 1)	4
Ramp Metering Issues Reported To ITS Or Electrical Maintenance (Chart 2)	5
Ramp Metering Complaints & Inquiries (Chart 3)	6
Ramp Metering Parameter Adjustments (Chart 4)	7
Traffic Data Collections (Chart 5)	8
Project Reviews (Chart 6)	9
Ramp Metering Related Meetings (Chart 7)	10
Ramp Metering Related Studies (Chart 8)	11
B. RAMP METER TRAFFIC DATA COLLECTION	12
C. CAPITAL PROJECT REVIEW	12
D. PERMIT PROJECT REVIEW	13
E. RAMP METER DEVELOPMENT PLAN (RMDP)	13
F. UNIVERSAL RAMP METERING SYSTEM (URMS)	13
G. STAGGERED METERING	14
H. TRAFFIC MANAGEMENT PLAN	14
I. TRAFFIC STUDIES	15
J. STATEWIDE RESEARCH TECHNICAL ADVISORY COMMITTEE (TAC)	22
APPENDIX	25
I DISTRICT 7 RAMP METERING HISTORY	26
II RAMP METERING BASICS	30
A. RAMP METERING BENEFITS	31
B. TYPES OF RAMP METERING	31
1. FIXED TIME / TIME OF DAY METERING	32
2. LOCAL MAINLINE TRAFFIC RESPONSIVE METERING	32
3. SYSTEM WIDE ADAPTIVE RAMP METERING (SWARM)	33

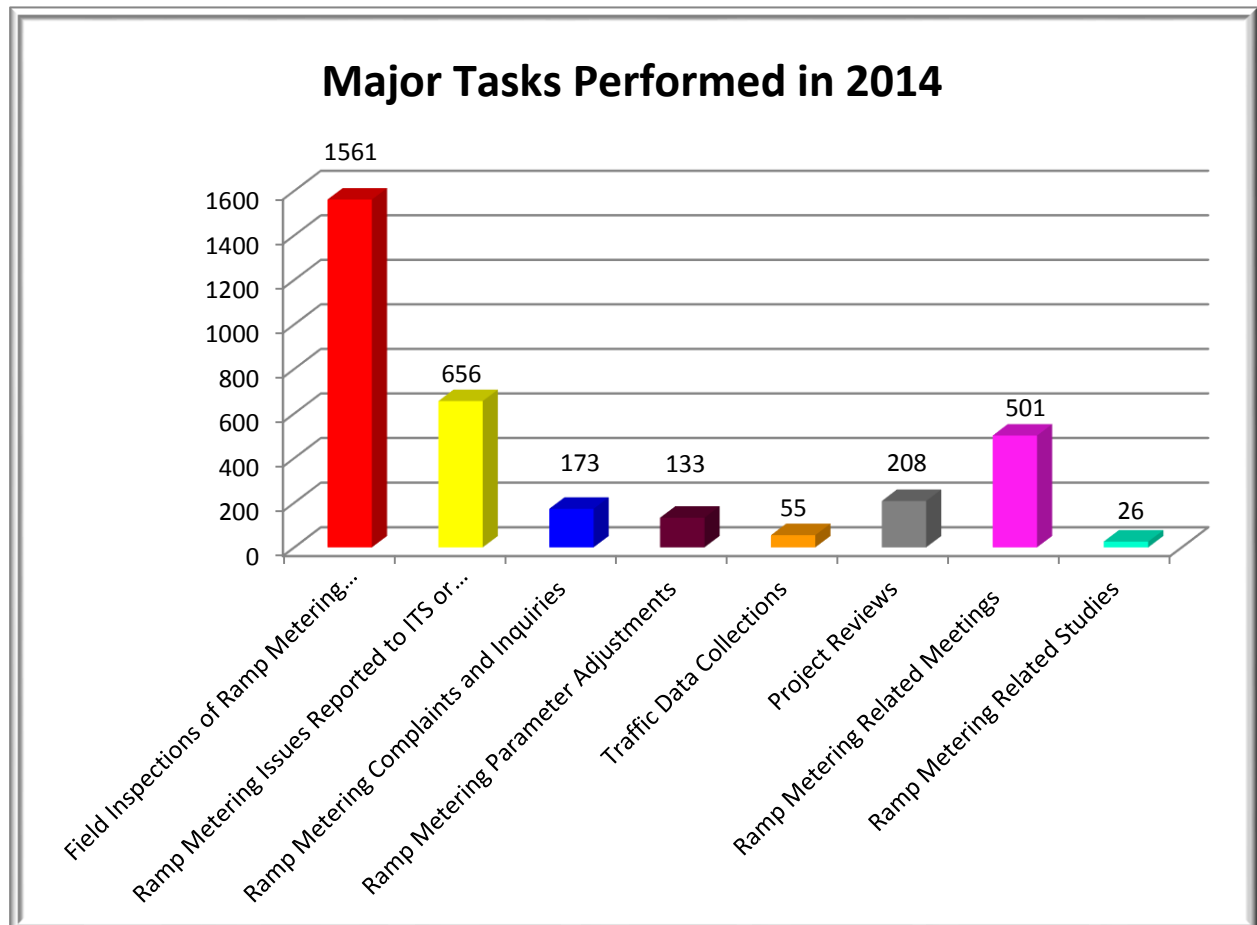
TABLE OF CONTENTS (Continued)

III	RAMP METERING TECHNOLOGY DEVELOPMENT	34
A.	ADVANCED TRANSPORTATION MANAGEMENT SYSTEM (ATMS)	34
B.	SYSTEM WIDE ADAPTIVE RAMP METERING (SWARM)	35
1.	SWARM 1	36
2.	SWARM 2A	37
3.	SWARM 2B	37
4.	SWARM COMBINATIONS	37
5.	ADVANTAGES OF SWARM	38
6.	DISADVANTAGES OF SWARM	38
C.	SATMS 3.0	38
D.	STATEWIDE RAMP METERING SYSTEMS	39
E.	ROUTE 210 STRATEGIC GROWTH PLAN – CONGESTION RELIEF PROJECT	39
IV	RESPONSIBILITIES	42
A.	RAMP METERING BRANCH	42
B.	ELECTRICAL MAINTENANCE BRANCH	42
C.	INTELLIGENT TRANSPORTATION SYSTEMS (ITS) BRANCH	43
D.	RAMP METERING WORKLOAD TRACKING SYSTEM	43
V	REFERENCES	47
VI	ATTACHMENTS	48
1	Route Responsibilities	49
2	Deputy Directive 35 – Ramp Metering	52
3	Ramp Metering Policy Procedures	53
4	Exceptions to Ramp Metering Policy Fact Sheet	58
5	Ramp Metering Policy on High Occupancy Vehicle (HOV)	59
6	Ramp Metering Workload Tracking	60

EXECUTIVE SUMMARY

The Caltrans District 7 Ramp Metering Annual Report highlights the major tasks performed and documents the accomplishments achieved by the Ramp Metering Branch during the 2014 calendar year in Los Angeles and Ventura Counties.

Some of the major tasks performed by the Ramp Metering Branch include:



The remaining responsibilities of the Ramp Metering Branch were to:

- Perform traffic engineering analyses at various ramps and connectors,
- Coordination with Headquarters on Reviewing and Updating Ramp Metering Design Manual and Standards (RMDM),
- Develop and implement statewide performance measures,
- Perform traffic engineering analyses to convert various existing ramp HOV bypass lanes to metered HOV or mix flow lanes,
- Review and update the Ramp Metering Development Plan (RMDP),

- Weekly RM staff meeting to internally share ideas to be consistent in handling RM operation,
- Discussing consistency with other Ramp metering Districts on metering operation,
- Development of the Universal Ramp Metering System (URMS) with Headquarters,
- Updating the ATMS to be integrated with the URMS,
- Development of the Dynamic corridor Ramp Metering System (DCRMS),
- Training for updating RM field Hardware controller to 2070 from existing 170,
- Quarterly meetings with Electrical Maintenance, TMC support and ITS group to discuss RM Issues,
- Coordinating with ITS (TMC Support) on updating existing Serial Communication to IP / Fiber,
- Consistency in Ramp Metering Operation for all Routes District wide,
- Consistency and internal discussions in review of Capital projects in planning and design stages,
- Consistency in coordination with Construction regarding on-going projects,
- Consistency in responding and dealing with issues and inquiries from public or various agencies,
- Coordination with UC Berkley and affiliates on development and research of new RM technology, and
- Assist in Developing District Traffic Management Plan during Design and Construction Stage.

District 7 Ramp Metering Branch is committed to the development and research of new and innovative RM technologies. Future Goals and Vision for the Ramp Metering Unit:

- Maintain consistency, coordination and team work in dealing with RM Design and Operation,
- Metering of existing and future HOV by-pass lanes District wide,
- Implementing 24/7 Ramp Metering operation District wide,
- Implementing DCRMS District Wide, as an enhancement to the existing locally traffic responsive,
- Introduction and Implementation of Staggered Metering for up to 3 metered lanes,
- Adaptation of Traffic Responsive Dark instead of the existing Green Ball mode to save energy, and
- Securing full-time dedicated support by I.T.S. and Electrical Maintenance in responding to RM issues.
- Support the Technical Advisory Committee (TAC) with various proposals. Currently, the TAC has proposed two (2) researches:
 - Planning to Better Manage On-ramp Queues at Ramp Meter
 - Queue Storage and Acceleration Lane Length Design at Metered On-ramp in California

District 7 Ramp Metering Branch is continually working to improve the ramp metering system. Some tasks performed are routine while others are special projects. Furthermore, some tasks were

performed in 2014 while other tasks were performed continually or as needed. These major tasks were divided into work categories as follows:

A. SURVEILLANCE AND MONITORING OF RAMP METERING OPERATION:

1. Field Inspections of Ramp Meter Elements (Chart 1)
2. Ramp Metering Issues Reported to ITS or Electrical Maintenance (Chart 2)
3. Ramp Metering Complaints & Inquiries (Chart 3)
4. Ramp Meter Parameter Adjustments (Chart 4)
5. Traffic Data Collections (Chart 5)
6. Project Reviews (Chart 6)
7. Ramp Metering Related Meetings (Chart 7)
8. New Tech Studies and Misc. Tasks (Chart 8)

B. RAMP METER TRAFFIC DATA COLLECTION

C. CAPITAL PROJECT REVIEW

D. PERMIT PROJECT REVIEW

E. RAMP METER DEVELOPMENT PLAN (RMDP)

F. UNIVERSAL RAMP METERING SYSTEM IMPLEMENTATION (URMS)

G. STAGGERED METERING

H. TRAFFIC MANAGEMENT PLAN

I. TRAFFIC STUDIES

The following sections summarize in depth the amount of work performed for each of these categories. All data included in the sections below was obtained from the Monthly Ramp Meter Reports filed by all Ramp Metering Engineers.

A. SURVEILLANCE AND MONITORING OF RAMP METERING OPERATIONS

The Ramp Metering Branch periodically performs field surveillance and corrects software and hardware problems associated with the metering operations. Ramp Metering Engineers observed traffic backups on the ramp, verify appropriate metering rates and check for any malfunctions with ramp meters and/or advanced warning signs. If the ramp meter is off during metering hours, the controller software program and cabinet hardware will be checked in order to diagnose the problem. Some issues will be corrected while other problems are reported to Electrical Maintenance or ITS Branch for repairs.

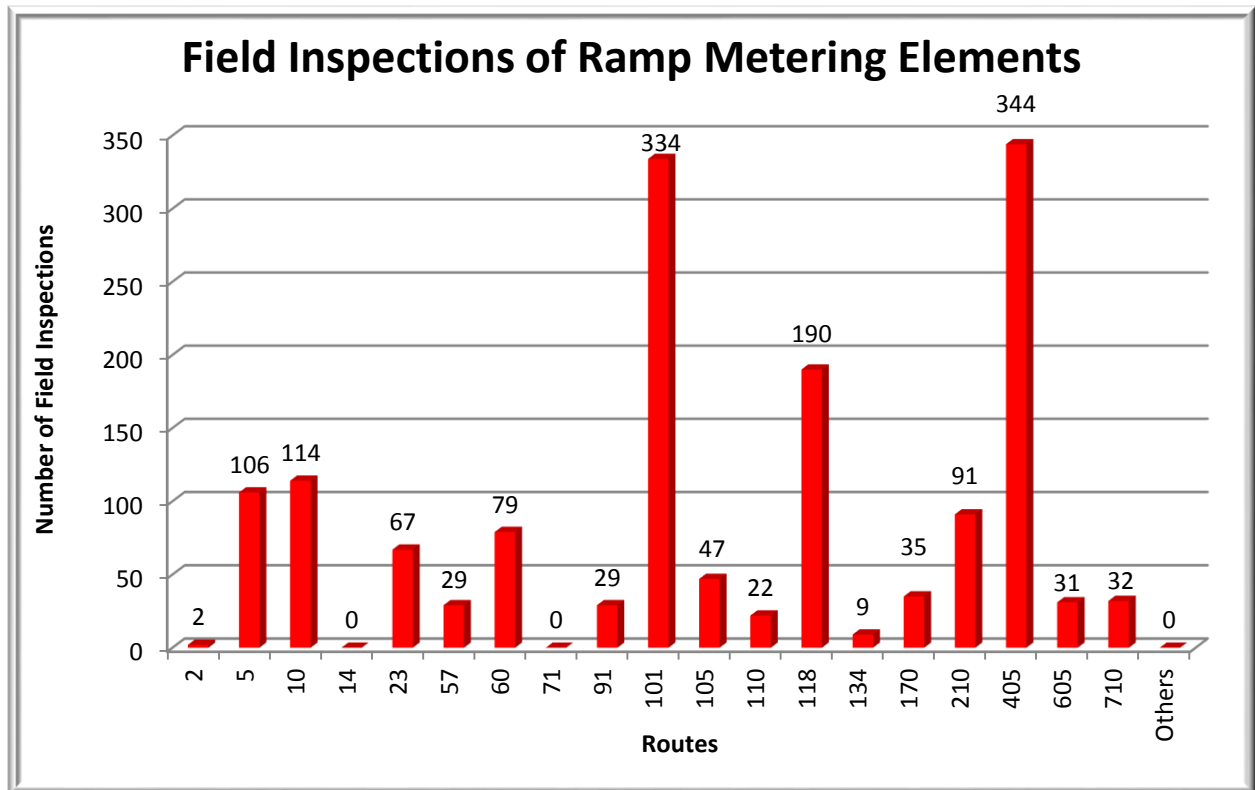


Chart 1

The Ramp Metering Branch performed 1561 field inspections of Ramp Metering elements. The reasons for checking these controllers varied from simply verifying the operations of the ramp meter to perform corrections or updates to the programmed software, and in some cases, resetting or replacing controller hardware. This may involve reopening the ramp meter controllers numerous times to solve recurring problems.

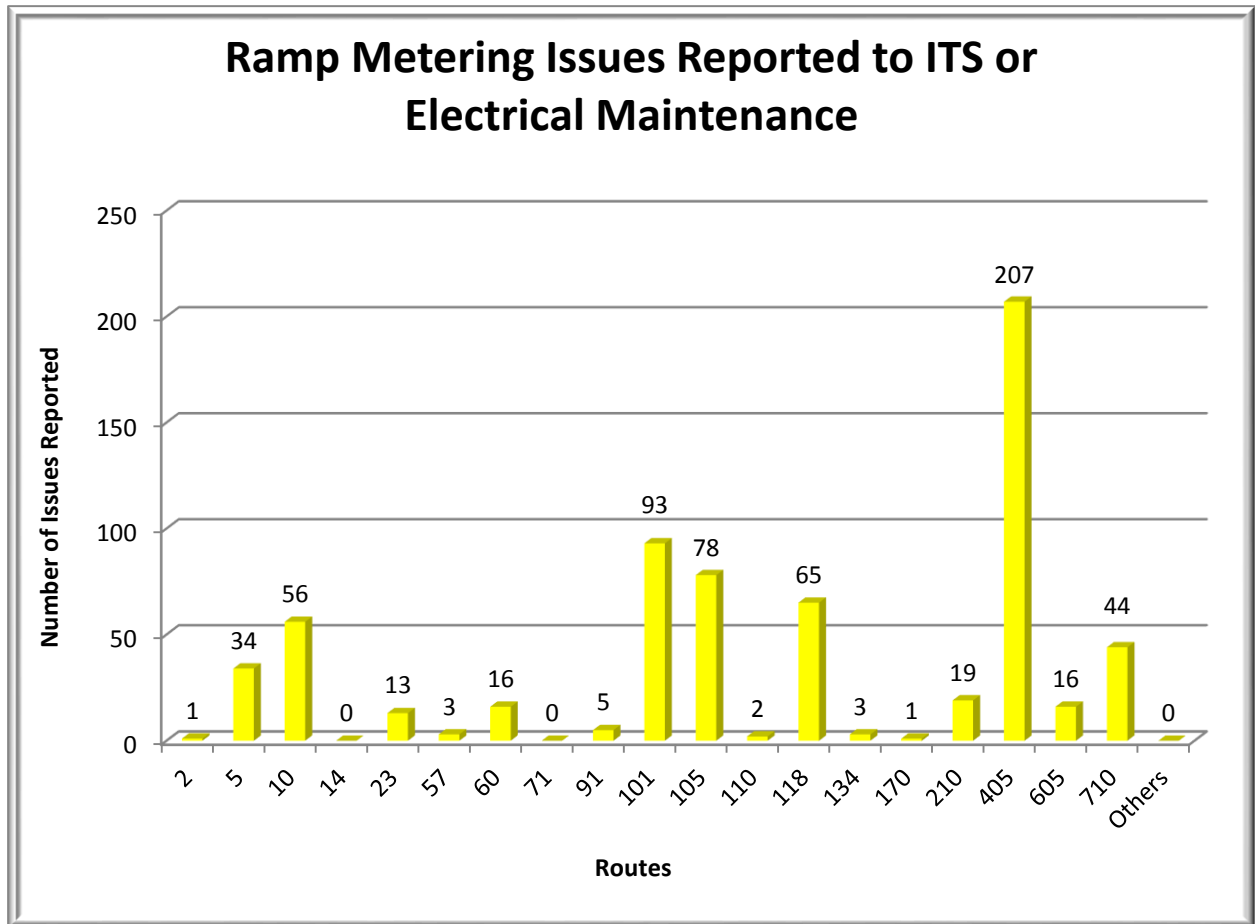


Chart 2

The Ramp Metering Branch reported 656 issues to I.T.S. or Electrical Maintenance.

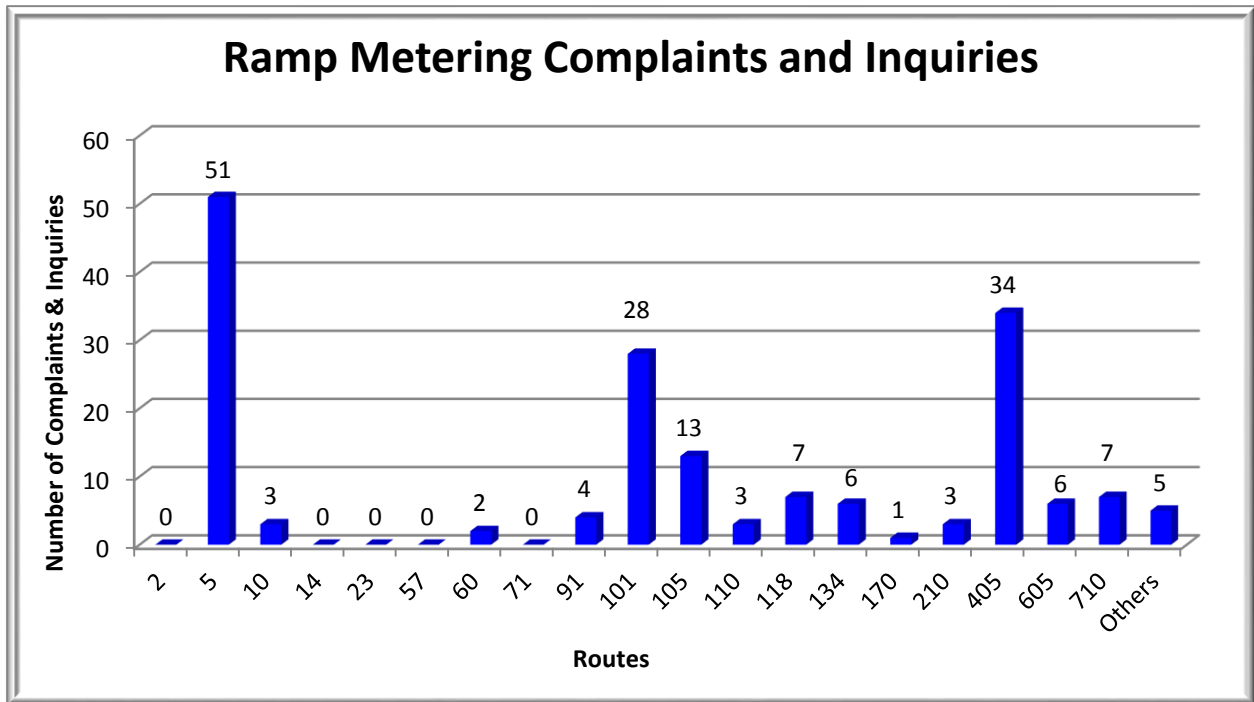


Chart 3

The Ramp Metering Branch received 173 complaints and inquiries from both private citizens and other public agencies that were responded and handled in timely manners. Some of the complaints included, but not limited to, meters stuck on RED, meters were off, and signs were knocked down.

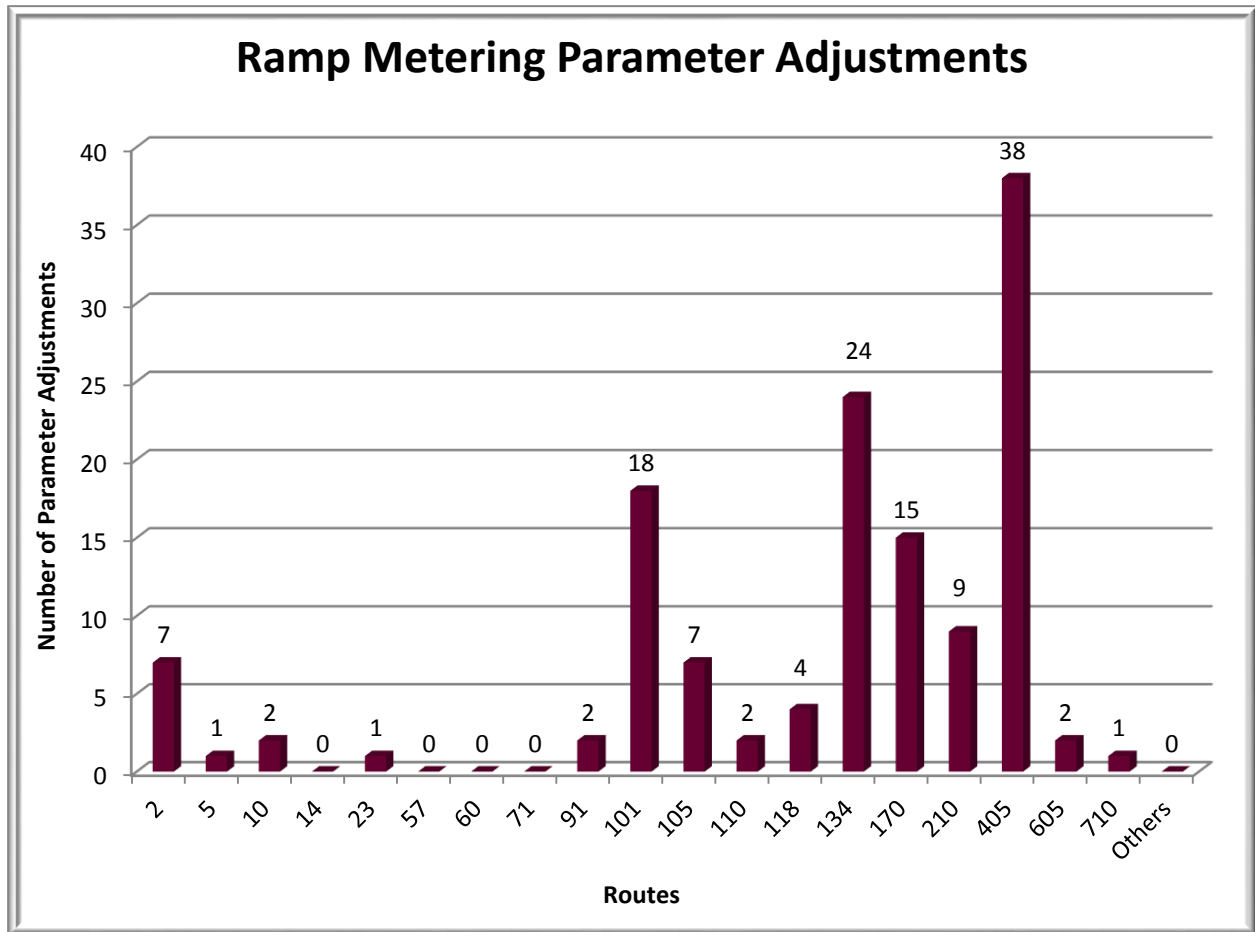


Chart 4

The Ramp Metering Branch modified 133 ramp metering program parameters. Ramp metering modifications were performed due to, but not limited to, malfunctions of ramp metering sensors, malfunctions of ramp metering loops, and changes in traffic conditions.

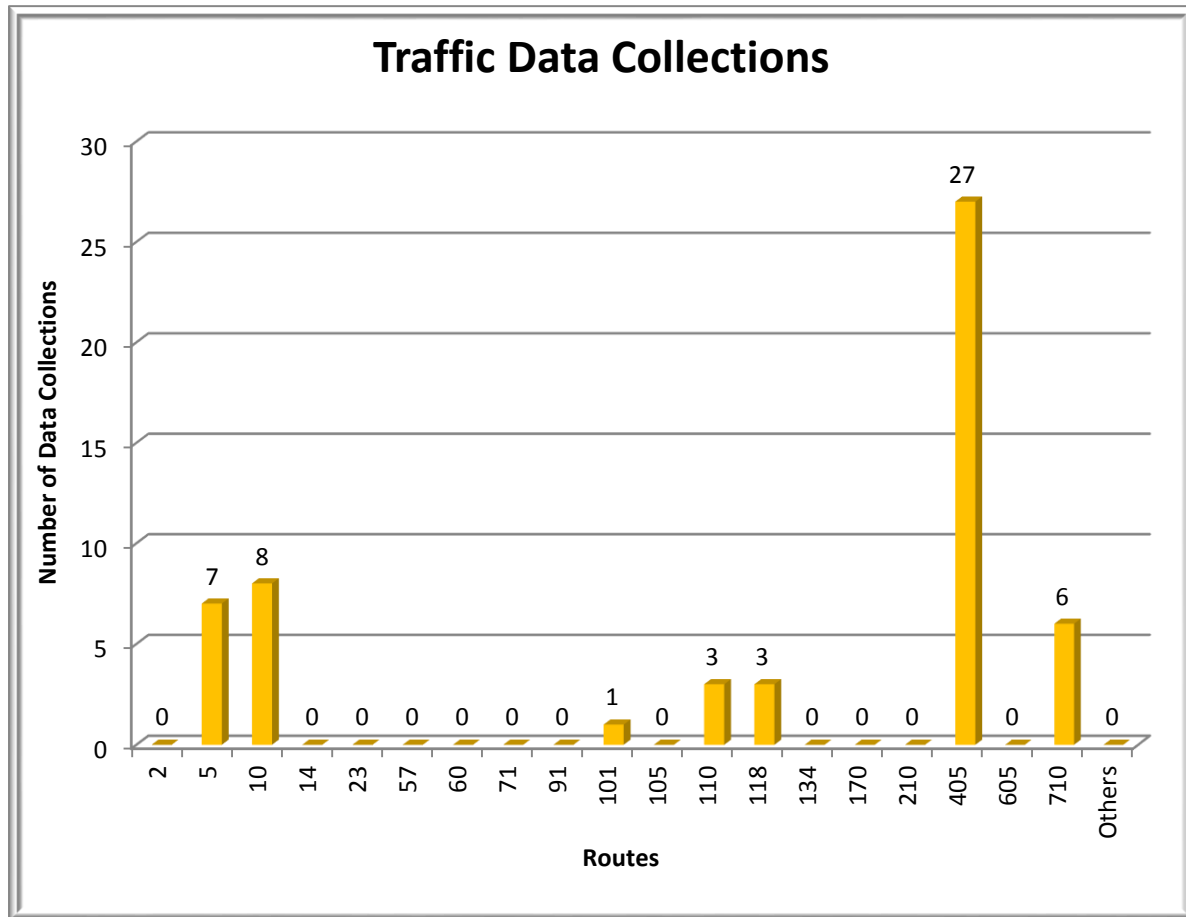


Chart 5

The Ramp Metering Branch performed 55 traffic data collections. The Ramp Metering Branch provided traffic data, which may include manual queue and demand data, ATMS generated reports and various other data to various District 7 Offices, Public Agencies, and the general public.

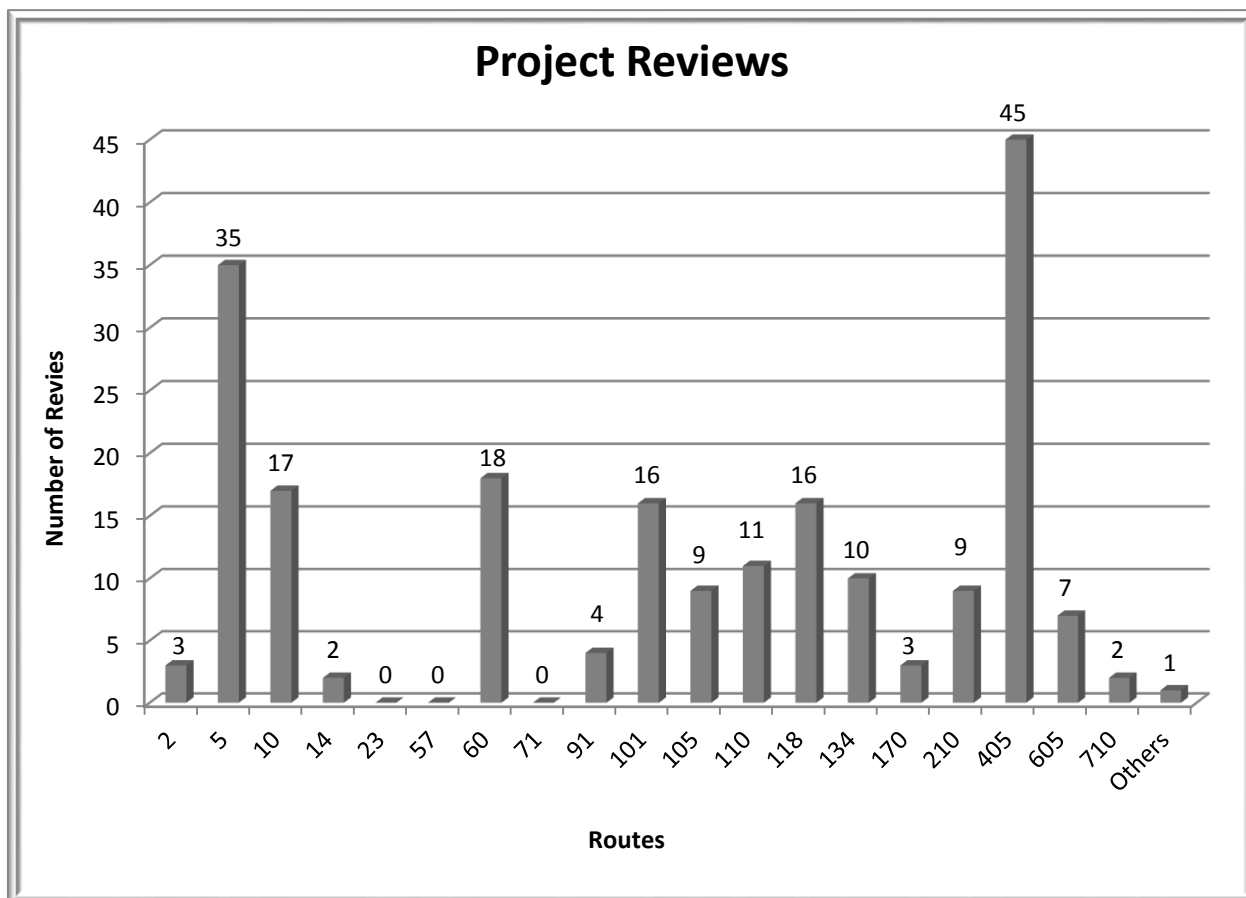


Chart 6

The Ramp Metering Branch performed 208 project reviews in different stages of design and construction. This may include reviewing the same projects at 35%, 65%, 95% and 100% submittals.

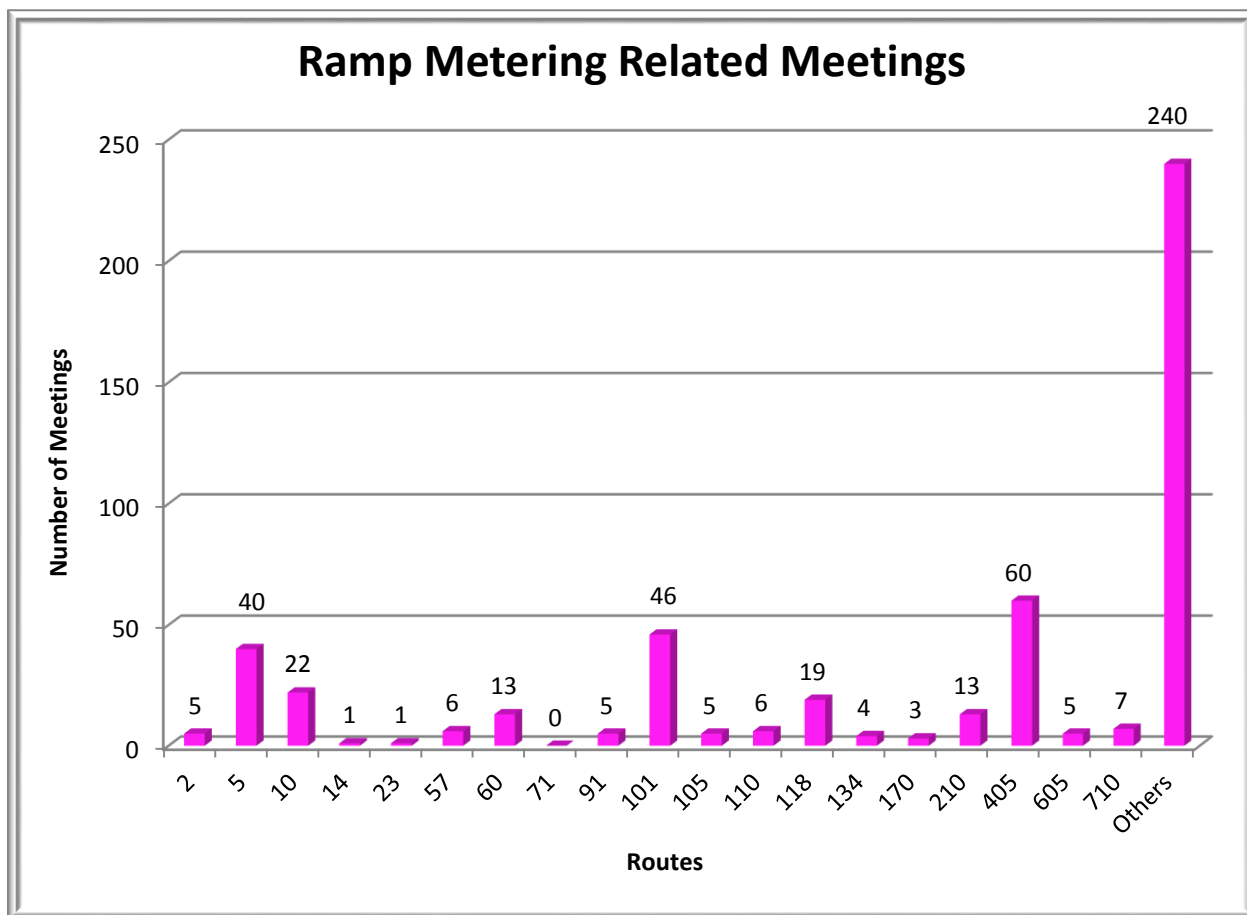


Chart 7

The Ramp Metering Branch attended 501 Ramp Metering related meetings.

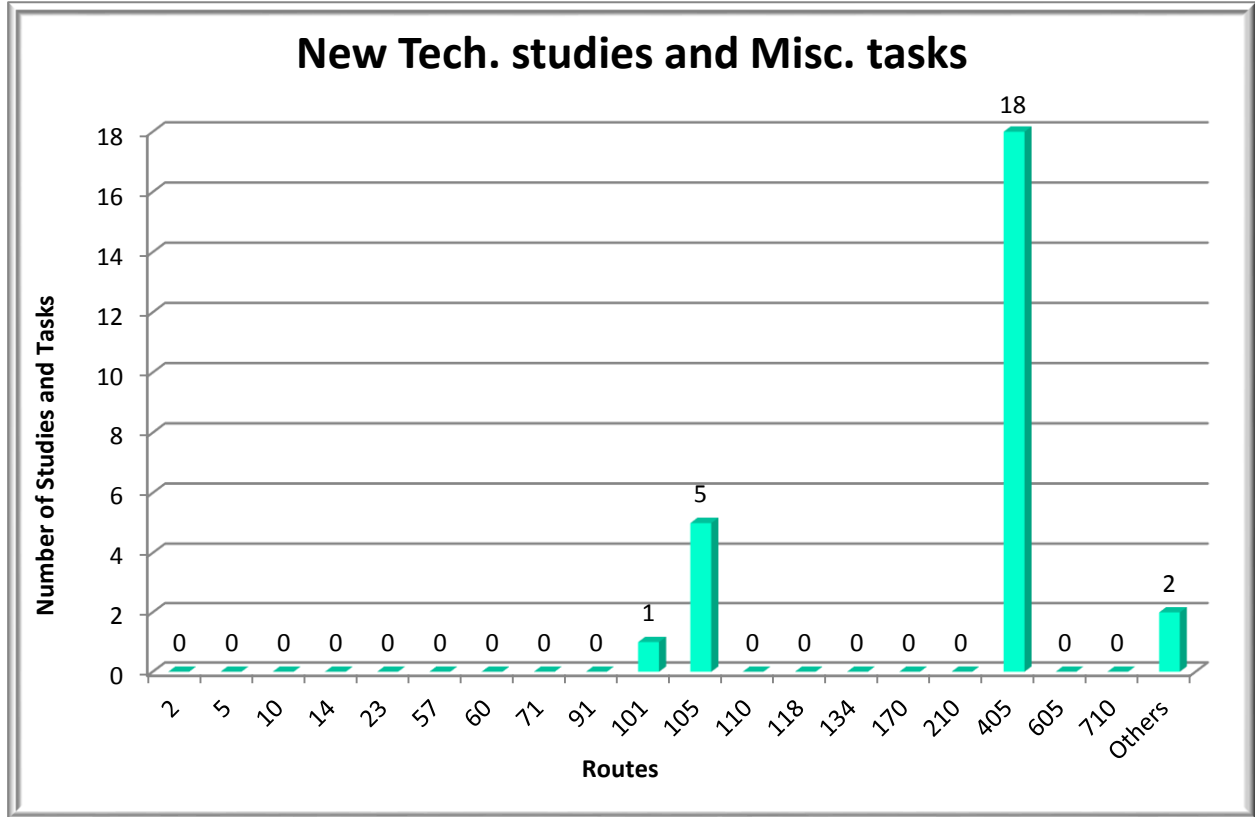


Chart 8

The Ramp Metering Branch performed 26 Ramp Metering related studies that include, but not limited to, new technology, new hardware, new software, new ramps, and new traffic conditions.

B. RAMP METER TRAFFIC DATA COLLECTION

There are three types of traffic data collections conducted by the Ramp Metering Branch:

1. Queue and Demand (Q & D)
2. High Occupancy Vehicle (HOV)
3. Violation Rates

"Q & D" traffic data collections are performed to study the operations of metered ramps, which include time and the extent of traffic backup (Queue) due to ramp metering. In addition to measuring the peak and total traffic demand on the ramp, the types of vehicles using the ramp are also recorded.

Q & D information helps to implement an effective ramp metering strategy. Metering rates are implemented according to type and volume of traffic demand at the on-ramp in relation to mainline traffic conditions, and to the traffic queued up behind the meter.

HOV traffic data collections are conducted at metered on-ramps with an HOV lane. The purpose of this data collection is to determine time intervals, types of vehicles (truck, buses, and motorcycles), peak and total HOV traffic demand, vehicle occupancy (examples, 2, 3, 4 persons per vehicle). The percentage of usage of the HOV lane, in relation to the metered mix-flow lane, is calculated with this information. In addition, the number of HOV lane violations is recorded. If the violation rate is determined to be high, this information is forwarded to the California Highway Patrol for enforcement.

These three types of traffic data collection should be conducted on a yearly basis at all active ramp meter locations. However, due to time constraints and limited resource allocations, these traffic data collection activities are currently performed as a result of public complaints, upcoming projects and developments impacting the operations of the ramp meter. Thus, if a public complaint related to excessive back-up on a ramp is received, a field review and a Q & D data collection might be conducted to properly investigate the problem and the metering rate may be adjusted if needed. In addition, if a project to construct a new ramp or modify an existing one is being proposed, then a traffic data will be collected, in order to assist in the new design. On-ramp traffic data collections might also be conducted during major studies or large-scale projects.

C. CAPITAL PROJECT REVIEW

The Ramp Metering Branch reviews numerous projects and gets involved in ramp meter related issues, during the following stages of a project:

1. PID (Project Initiation Document)
2. PSR (Project Study Report)
3. PR (Project Report)
4. PS&E (Plans, Specifications and Estimate)
5. Pre, during, and post construction

D. PERMIT PROJECT REVIEWS

The Ramp Metering engineers review and make comments on ramp meter related issues involved in permit projects and oversight projects, which are usually prepared by consultants on behalf of local cities, counties or other agencies.

E. RAMP METER DEVELOPMENT PLAN (RMDP)

The first 10-year statewide RMDP report was completed in 1997. The next one was due to be updated by 2008; however, an updated RMDP report was initiated in 2004 and published in July of 2005. This 10-year report contained an inventory of all on-ramps (metered and non-metered), metered connectors, and a listing of on-ramps proposed or funded to be metered within the next 10 years throughout the state. The last statewide RMDP was published in December 2013. District 7 takes part in the write-up of the statewide RMDP, as well as providing the District 7 ramp meter inventory, technical support, and other information and assistance as needed. The latest statewide RMDP can be found at: http://www.dot.ca.gov/hq/traffops/trafmgmt/ramp_meter/

On top of assisting HQ with the statewide RMDP, District 7 also prepares the 10-year district RMDP. Like the statewide RMDP, the 10-year district RMDP report contains an inventory of all on-ramps (metered and non-metered), metered connectors, and a listing of on-ramps proposed or funded to be metered within the next 10 years in District 7. The last District 7 RMDP was published in January 2009, which can be found at: http://www.dot.ca.gov/dist07/resources/ramp_metering/docs/District%207%202009%20Ramp%20Metering%20Development%20Plan.pdf.

Besides the 10-year district RMDP, District 7 also updates the district inventory annually (or whenever deems appropriate such as a change in ramp metering staff, reassignments of route responsibilities, etc.)

F. UNIVERSAL RAMP METERING SYSTEM (URMS) IMPLEMENTATION

Caltrans strives to unify the ramp metering operating software systems to minimize the operations and maintenance costs. A software package, called Universal Ramp Metering System (URMS), was therefore developed and is currently being evaluated statewide. URMS is the next generation of ramp metering operations software that operates on the new 2070 controllers to be used by all Caltrans Districts for Ramp Metering application in the State of California. It was created to replace TOS, SATMS and SDRMS used by Districts 4, 7, 8, 11 and 12. It combines all the ramp metering features implemented by the Districts in the 3 different software versions running on the old 170 controllers.

District 7 has successfully implemented the URMS application by installing 2070 controllers at five on-ramp locations along Routes 2, 57 and 134 in District 7. In addition, sixteen 2070 controllers deploying the URMS, has been installed and in operation at all ramp meter locations along Route 405 in the northbound and southbound directions,

between Routes 10 and 101, as part of Route 405 HOV project, EA 120304. Furthermore, the on-going contract with DELCAN to integrate the URMS with the Advanced Transportation Management System (ATMS) has ended. Thus, remote control of the 2070 ramp meter controllers from the TMC is now achieved; the Ramp Meter Engineers could fully program the 2070 Controllers to run local traffic responsive or even dynamic corridor ramp metering software using the ATMS hosted in the TMC.

G. STAGGERED METERING

Staggered Metering is a metering operation strategy that consists of split-time discharge of vehicles per 2 or more metered lanes at a particular on-ramp location. Unlike “Same” cycle metering, when vehicles are discharged at the same rate and time for all metered lanes, “Staggered” cycle metering discharges vehicles at the same or different metering rate (depending on the selected settings), but following a split timing method, where start of metering cycle is offset by a fractional time, thus allowing for consecutive discharge.

District 7 had implemented staggered metering operations at Harvey Ave. to WB Rte. 134 and at the following locations on Route 405:

NB Route 405 on-ramps

1. Pico/Cotner
2. EB Wilshire
3. WB Wilshire
4. Sunset
5. Moraga
6. Mulholland

SB Route 405 on-ramps

1. Ventura
2. Mulholland
3. Getty Center
4. EB Sunset
5. WB Wilshire
6. EB Wilshire

The hardware at these on-ramps were upgraded to accommodate such an application. The upper and lower ramp meter signals, at both sides of the ramp, were changed to 3-section 12-inch heads and the 170 controller using SATMS was changed to 2070 controller running the URMS software.

H. TRAFFIC MANAGEMENT PLAN

The Ramp Metering Branch also provides assistance with the development of Traffic Management Plans during the design and construction stages. The Ramp Metering Branch assisted with the highly publicized LA-405 ‘Carmageddon’ Freeway Closure Project. Ramp Metering personnel during the freeway closure were extensively involved

to optimize the traffic flow in the mainline and reduces the back up to city streets and assisted in improving traffic operations through controlled ramp metering for the surrounding freeway Routes (Route 10 and Route 101), and along the open sections of Route 405.

I. TRAFFIC STUDIES

LA-5

There are two on-going major HOV projects along Rte. 5 since 2013:

- The first segment is from Rte. 134 to Rte. 118, which is about 13 miles and is scheduled to open to the public late 2014 or early 2015. This section will join the existing HOV lane at 118 that leads up to Rte. 14.

Due to this construction, in June 2014, Scotts Rd. on-ramp to SB Route 5 was permanently closed; thus, traffic of this on-ramp has been diverted to EB Burbank on-ramp to SB Rte. 5. The new traffic pattern at this on-ramp required an engineering study. This study included collecting traffic data (Queue, Demand and Occupancy counts) and ATMS data (speed, occupancy, volumes) in the AM and PM peak hours. Based on this study, new parameters and discharge rates were derived and implemented at this on-ramp.

- The other on-going major project is from Orange County line to Rte. 605. This project will add a mixed flow lane as well as an HOV lane in each direction of the freeway. These lanes are scheduled to be opened to the public by 2018.

During different phases of project initiation, project development, and construction of these projects, the Ramp Metering Branch has been extensively involved to optimize the traffic flow in the mainline and reduces the back up to city streets. The Ramp Metering Branch will continue to monitor and assist in improving traffic operations through ramp metering. Once these projects are completed, the Ramp Metering Branch will likely perform traffic studies to set appropriate ramp metering parameters for optimum traffic operations.

LA-10

LA-10 PM R2.15/R14.83 - Santa Monica Freeway Operational Study @ Various Metered On-Ramps with HOV-by Pass Lane-December 2014

Reason for the Study: The Office of ITS proposed a project to meter the existing HOV-bypass lane or to convert the existing HOV by-pass lane to a metered mixed flow lane. The study was requested by ITS in order to proceed with their proposal, which needed a Fact Sheet document. The Fact Sheet document is required for this type of project.

Data Gathering: Queue and Demand and Occupancy counts were conducted throughout November and December 2014 during various days. These traffic counts were conducted during the following hours: 0630 to 930 and 1600 to 1900. ATMS data (speed, occupancy, volumes, etc.) for Route 10 was gathered during the same times and days as the traffic counts. Field surveillance was also conducted at the on-ramps and on Route 10 mainline during the same days and times.

Finding: Based on the field surveillance and data gathered an Operational Study was produced and the Fact Sheet was completed. These two documents were provided to the Office of ITS.

LA-105

Route 105 to NB-110 Connector - Ramp Meter Operational Study -June 2014

Reason for the Study: Ramp Metering Branch (RMB) received a citizen complaint, in regards to the connector meter. It was operating on “green mode” while the Northbound Route 110 was congested.

Data Gathering: Queue, Demand and Occupancy counts were conducted on May 20, 21 and June 3, 4, 2014 from 0530 to 1130 and 1300 to 1930 hours. ATMS data (speed, occupancy, volumes) for the northbound lanes of Route 110 was gathered during the same time and days as the traffic counts. Field surveillance was also conducted along the connector and the northbound lanes of Route 110 during the same days and times.

Finding: Based on the field surveillance and data gathered the connector meter controller was reprogrammed with new parameters (critical volume, critical occupancy, critical speed, etc.) in order to handle the new traffic demand and Traffic pattern.

EB-105 to NB-405 Connector - Connector Turn On Traffic Study-June 2014

Reason for the Study: The connector meter was turned off, for numerous years, due to extensive wire theft. The study was needed to turn on the meter after Electrical Maintenance repaired this location. The “turn on study” was expedited due to the lack of time and resources.

Data Gathering: ATMS data (speed, occupancy, volumes, etc.) for the northbound lanes of Route 605 was gathered from June 16 -22, 2014 during the proposed metering hours 0530 to 1100, and 1330 to 1930. Field surveillance was also conducted along the connector and the northbound lanes of Route 605 during the same times and days.

Finding: Based on the field surveillance and data gathered the meter was turned on. The meter controller was reprogrammed with new parameters (critical volume,

critical occupancy, critical speed, etc.) based on the newly acquired traffic data and field observations.

LA 110

Reason for Study: South Bay Dynamic Corridor Congestion Management (DCCM) project selected a pilot project on Harbor freeway to improve congestion between the limit of Route 405 and Route 110. This is part of Measure R program In Caltrans District 7 in conjunction with Metro (Los Angeles County Metropolitan Transportation Authority) and SBCCOG (South Bay Cities Council of Governments Board). As part of the improvements to selected pilot project, all the input from the on-ramps in the vicinity were looked at and there are 5 on-ramps with High Occupancy Vehicle (HOV) lane out of total of 8 on-ramps. It was decided to study this HOV lane either to meter or convert to mix flow lane to control the input to the mainline freeway.

Data Collection: Following are the 5 HOV on-ramps within the project limit.

1. NB 110 from 190th Street
2. SB 110 from Imperial Highway
3. NB 110 from EB Rosecrans
4. NB 110 from WB Rosecrans
5. SB 110 from Redondo Beach

Field observations and traffic counts were conducted during peak hours (6 AM to 9 AM and 3 PM to 6:30 PM) on typical weekday, between October 14 and 16. Due to the time and funding restriction, each location was counted by one person for one day only.

Conclusion: Based on the traffic study, following two on-ramps are recommended to convert HOV lane to a mix flow lane and other three are recommended to meter HOV lane.

NB 110 from 190th Street:

This is a two lane diamond on-ramp with HOV lane on the left and the metered lane on right with the storage of only 10 vehicles. The AM peak hour is about 400 cars and the PM peak hour is about 900 cars. The dual left turn from EB 190th Street experience long backups and during the green phase, ramp queue extends beyond the entrance leading to a high numbers of violators. The metering rate at this on-ramp during peak hours is 15 cars per minute which is 900 vehicles per hour. The high occupancy vehicles make up only 12% of the total volume. The conversion of HOV lane to mix flow lane will allow more storage and better metering rate at this on-ramp. Also, the on-ramp traffic merges onto the mainline just before Route 91 contributing to heavy weaving in the vicinity of the interchange. Furthermore, the connector from NB 110 to EB 91 backs up to the mainline near the on-ramp merging area. The uncontrolled vehicles from HOV lane and high volume from the metered lane adds the issue of bottleneck near Route 91 just upstream of this location.

Recommendation: Due to high volume, low HOV percentage and short storage, it is recommended to convert the HOV lane to a mix flow lane at this on-ramp location.

SB 110 from Imperial Highway:

This is a two lane diamond on-ramp near the interchange with Route 105 and has 26 cars storage. The AM peak hour volume is about 725 and the PM peak hour volume is 1100 vehicles, which makes this location very heavy on-ramp. The percentage of HOV is 19% in the AM peak and 22% in the PM peak, which is a moderate volume. This on ramp merges in the curve area just south of the merge from Route 105 connectors and creates huge weaving area. The uncontrolled vehicles from HOV lane and high volume from the metered lane adds the issue of bottleneck near the merge area of this location. The conversion of the HOV lane to a mix flow lane will allow tighter much better metering rate.

Recommendation: Due to very high volume at this on-ramp and in the area of merge with Route 105 connectors, it is recommended to convert this HOV lane to mix flow lane. Based on the study, following three HOV on-ramp locations are recommended for metered HOV lane.

NB 110 from EB Rosecrans Avenue:

This is two lane loop on-ramp has metered lane on the right and HOV lane on the left and has 14 car storage. Both AM and the PM peak hour volume is about 400 cars which is moderate volume. The HOV is 12% in the AM peak and 14% in the PM peak hour which is low percentage. There is a park and ride facility next to the ramp. The uncontrolled HOV lane volume from this on-ramp and the WB Rosecrans on-ramp joins the 5th lane of mainline freeway just upstream of bottleneck at Route 105. The metering of the HOV lane will help in reducing the severity of the bottleneck.

Recommendation: Considering the moderate volume on the ramp and park and ride facility next to the ramp, it is recommended to meter the HOV lane at this location.

NB 110 from WB Rosecrans Avenue:

This two lane diamond on-ramp has metered lane on the right and HOV lane on the left with 30 cars of storage. The AM peak hour is about 400 vehicles and the PM peak hour volume is about 660 vehicles. The percentage of HOV is 13 % in the AM peak and 18% in the PM peak hour which is a moderate percentage. There is a park and ride near this on-ramp. The uncontrolled HOV lane volume from this on-ramp and the EB Rosecrans on-ramp joins the 5th lane of mainline freeway just upstream of bottleneck at Route 105. The metering of the HOV lane will help in reducing the severity of the bottleneck.

Recommendation: Considering the moderate volume on the ramp and park and ride facility next to the ramp, it is recommended to meter the HOV lane at this location.

SB 110 from Redondo Beach Blvd.:

This two lane diamond on-ramp has metered lane on the right and HOV lane on the left with 24 car storage. The AM and the PM peak hour volume is about 600 vehicles which is considered moderate to high. This on-ramp has high 34% of HOV which is high HOV on-ramp. When the ramp meters, the queue backs up to near the entrance and there are moderate amount of violators observed at that time. This ramp has high percentage of HOV volume and is uncontrolled just upstream of Route 91 interchange. By metering the HOV lane, the weaving at the merge will be easier and will help the bottleneck upstream near Route 405.

Recommendation: Since the volume is moderate to high and the on-ramp has high percentage of HOV, it is recommended to meter the HOV lane at this on-ramp

The above three on-ramps will be greatly benefited by metering HOV lane. The uncontrolled platoon of vehicles breaks down the freeway at the merge, increase the sideswipe type of accidents at the merge and promote violations. The metering of HOV lane will reduce all of the above and help in overall safe operation of the meter.

LA-118 & Ven-118

Ven. 118 EB &WB traffic Studies

Reason for Study: The project proposed to upgrade the existing Transportation Management System (TMS) elements, consisting of closed circuit television (CCTV) cameras, ramp metering systems (RMS), vehicle detection stations (VDS), changeable message signs (CMS), data nodes (DN), and cable nodes (CN) to Internet Protocol (IP) ready network on Route 23 at New Los Angeles Avenue (PM 11.4) and on Route 118 from Princeton Avenue (PM 19.60) to the Los Angeles County Line (PM 32.60). All the input from the on-ramps in the vicinity were looked at, 17 on-ramps in the WB and 16 on-ramps in the EB, all the on-ramps with High Occupancy Vehicle (HOV) lane were studied to decided either to meter or convert to mix flow lane to control the input to the mainline freeway.

Data Gathering: Queue and Demand and Occupancy counts were conducted throughout November and December 2014 during various days. These traffic counts were conducted during the following hours: 0630 to 930 and 1600 to 1900. ATMS data (speed, occupancy, volumes, etc.) for Route 118 was gathered during the same times and days as the traffic counts.

Field surveillance was also conducted at the on-ramps and on Route 118 mainline during the same days and times. Due to the time and funding restriction, each location was counted by one person for one day only.

Following are the 17 HOV on-ramps in the WB and 16 HOV on-ramps in the EB within the project limit.

WB Route 118

1. Rocky Peak On-Ramp
2. Kuehner Dr. On-Ramp
3. Yosemite Ave NB and SB On-Ramps
4. Stearns NB and SB On-Ramp
5. Tapo Cyn NB and SB On-Ramp
6. Sycamore NB and SB On-Ramp
7. Erringer NB and SB On-Ramp
8. First St NB and SB On-Ramps
9. Madera On-Ramp
10. Collins On-Ramp
11. Princeton On-Ramp

EB Route 118

1. Princeton On-Ramp
2. Collins On-Ramp
3. First St SB and NB On-Ramps
4. Erringer SB and NB On-Ramp
5. Sycamore SB and NB On-Ramp
6. Tapo Cyn SB and NB On-Ramp
7. Stearns SB and NB On-Ramp
8. Yosemite Ave SB and NB On-Ramps
9. Kuehner Dr. On-Ramp
10. Rocky Peak On-Ramp

Conclusion: As part of the ramp metering upgrade, the existing HOV (bypass) lanes at the following three locations, within the project limits, were decided to be converted into mix flow metered lanes:

1. Princeton Ave on-ramp to EB Route 118
2. Collins Dr. on-ramp to EB Route 118
3. NB First St on-ramp to EB Route 118

LA-405

Traffic studies, which included Queue, Demand and traffic operations, were conducted at various on-ramps on Route 405 within the Design Build project, 9 on-ramps in each direction NB and SB. After ensuring that Ramp metering elements are installed according to the SSP, SP and Contract Plans, a field observations and traffic counts were conducted

at the following NB and SB on-ramps during the peak hours (5 AM to 8:30 PM) on typical weekdays and weekends, during the whole period of 2014.

NB Route 405 on-ramps

7. Pico/Cotner
8. Santa Monica
9. EB Wilshire
10. WB Wilshire
11. Sunset
12. Moraga
13. Getty Center
14. Mulholland
15. Green Leave

SB Route 405 on-ramps

7. Ventura
8. Valley Vista
9. Mulholland
10. Getty Center
11. WB Subset
12. EB Sunset
13. WB Wilshire
14. EB Wilshire
15. Santa Monica

Finding: Based on the field surveillance and data gathered all the meters was turned on. New concept of traffic operation were introduced with the 2070 controllers allowing Staggered and platoon Metering, The 2070 controller were programmed with new parameters (critical volume, critical occupancy, critical speed, etc.) based on the newly acquired traffic data and field observations.

LA-405 Connector

NB-405 to EB-105 Connector - Ramp Meter Operational Study -August 2014

Reason for the Study: Ramp Metering Branch (RMB) received a citizen complaint, in regards to long traffic queues along this connector during the afternoon metering hours.

Data Gathering: Queue, Demand and Occupancy counts were conducted on May 14 and 28, 2014 from 1330 to 1930 hours. ATMS data (speed, occupancy, volumes) for the eastbound lanes of Route 105 was gathered during the same time and days as the traffic counts. Field surveillance was also conducted along the connector and the eastbound lanes of Route 105 during the same days and times.

Finding: Based on the field surveillance and data gathered the observed traffic queues were normal, within the expected length for this type of connector metering.

Other Routes

Traffic studies were also done at various locations in the District:

- RTE 101 at Calabaras Rd
- RTE 101 at Roadway Calabaras
- RTE 101 at S/B Tampa
- RTE 101 at S/B Reseda
- RTE 23 at SB Sunset Hills
- RTE 23 at Olsen 2
- RTE 23 at 10 locations
- NB-VEN-101 at Wendy Dr. NB 1
- NB-VEN-101 at Wendy Dr. NB 2
- NB-VEN-101 at 3 locations (Rice, NB 2, SB 1)
- RTE 101 at Moorpark
- RTE 101 at Hamshire
- RTE 101 at 101/23 interchange

J. STATEWIDE RESEARCH TECHNICAL ADVISORY COMMITTEE (TAC)

¹Federal regulations (Title 23, Section 135) require that each state to develop a statewide transportation plan process including updates of the state transportation plan. Senate Bill (SB) 391 (Liu, 2009) requires Caltrans to submit the California Transportation Plan (CTP) to the Transportation Agency by December 31, 2015. SB 391 requires Caltrans to address in the CTP how the state will achieve maximum feasible Greenhouse Gas (GHG) emission reductions and to identify the statewide integrated multimodal transportation system needed to achieve these results.

The Technical Advisory Committee (TAC) will assist Caltrans in developing the technical analysis for the California Transportation Plan 2040 (CTP 2040). These guidelines define the roles and responsibilities of TAC members, as well as the roles of Caltrans staff in the development of the CTP 2040 that will enable the State to identify the system that will achieve maximum feasible GHG emission reductions.

Role of the TAC

1. Identify surface transportation GHG emission reduction strategies
2. Build scenarios (Scenarios shall be defined as a strategy or multiple strategies grouped together)

3. Assess how these scenarios will interact with Metropolitan Planning Organizations (MPOs), Sustainable Communities Strategy (SCS), and Regional Transportation Planning Agencies (RTPAs) strategies and/or scenarios
4. Present recommendations to the Policy Advisory Committee (PAC)
5. Analyze and interpret model runs
6. Recommendations on post-processing as needed

Role of Caltrans

1. Provide leadership and coordination for the overall effort.
2. Facilitate TAC meetings in a professional manner by ensuring appropriate dialogue.
3. Ensure adequate time to review meeting materials and draft products.
4. Encourage collaboration and consensus.
5. Post relevant documents on the web portal.
6. Manage meeting logistics.
7. Collect and record discussions, and synthesize meeting inputs.
8. Prepare the CTP, conduct outreach events, and develop marketing and outreach materials as needed.

¹http://www.dot.ca.gov/hq/tpp/offices/osp/ctp2040/ctp2040_tac/apr_25_2013_tac_mtg/CTP2040_TAC_Roles_and_Responsibilities_Final.pdf

The TAC and Ramp Metering

The TAC proposed the following researches that involve ramp metering:

- 1) Planning to Better Manage On-ramp Queues at Ramp Meter

The following was prepared by the University of California, Irvine. The proposal includes the followings:

- a) Ramp Metering Overview
- b) Caltrans Ramp Metering Operation
- c) On-ramp Queue Management Strategies
- d) Guidelines for Providing Sufficient Storage by: Queue Overspill Detection Detectors on the On-ramp, Queue Overspill Detection using Loop Detector Data, Ramp Queue Length Estimation
- e) Conservation model such as: Queue detector occupancy data based method, Kalman Filtering method, Method based on Traffic flow theory, Other Queue Detection Technologies, Queue Override Control Algorithms, WSDOT queue control algorithm Minnesota Algorithm, Queue override control algorithm in Melbourne, Australia, Queue override control algorithm in SATMS / OCRMS, Queue override control algorithm in SDRMS, Queue override control algorithm in TOS
- f) Jurisdictional Cooperation
- g) Deliverables:

- 1) Possible inappropriate metering setup
 - 2) High on-ramp flow
 - 3) Mainline congestion
 - 4) Combination of freeway mainline congestion and high on-ramp flow
- h) Recommendation:
 - 1) Ramp metering operation improvement
 - 2) Infrastructure improvement
 - 3) Innovative operational strategies
- 2) Queue Storage and Acceleration Lane Length Design at Metered On-ramp in California

The following was prepared by the Center for Advanced Transportation Education and Research, University of Nevada, Reno. The proposal includes the followings:

- a) Develop a Project Team
- b) Technical Literature Review
- c) Preliminary Pilot Study
- d) Model Development
- e) Data Collection and Analysis
- f) Development of Standards of Metering On-Ramp Design
- g) Preparing Study Report and Final Report

APPENDIX

I. DISTRICT 7 RAMP METERING HISTORY



Old LATMC

In 1965, the Freeway Operations Department, as it was called, was created in District 7 to locate, analyze and solve operational deficiencies on the existing freeway system. The first experimentation with ramp metering in District 7 occurred on the Labor Day weekend in the midst of 1960's on the Southbound Route 14 to the Southbound Route 5 Freeway connector. The connector was manually metered with temporary signals to prevent the Southbound Route 5 freeway from 'breaking down'. The metering operation was a complete, instant success.

On April 11, 1967, the District's first two permanent fixed-time ramp meters were installed on the northbound Hollywood Freeway (Route 101) at Sunset Boulevard and Hollywood Boulevard. The project was successful in relieving congestion on the freeway mainline without seriously affecting surface street operations. Freeway delay was reduced by about 75%.

In the early 1970's, District 7 created the Los Angeles Area Freeway Surveillance and Control Project (LAAFSCP). The Harbor Freeway (Route 110), Santa Monica Freeway (Route 10) and the San Diego Freeway (Route 405) highlighted this experimental project, known as the 42-mile loop. The system had two objectives. The first objective was to test and evaluate various techniques for improving movement of people and goods on the freeway system by reducing traffic delay and increasing traffic safety. The second objective was to integrate those techniques that can show a great promise into an effective traffic management system.

The LAAFSCP consisted of a vast network of traffic sensors, telemetry equipment, and a computer workstation. The computer workstation was merely a map display and an operator's console, which showed 24-hour real-time traffic data, including freeway mainline volumes, speeds, occupancies, ramp volumes, travel time and traffic delay. From this humble beginning, the current high tech Los Angeles Regional Transportation Management Center (LARTMC) was completed in 2006 and has evolved to be on the right track for success. District 7 is vigorously and continually working to further improve the system.

Traffic responsive ramp metering was also tested in the LAAFSCP project. The traffic responsive logic showed a great improvement over the existing fixed-time ramp metering software.

Also in the early 1970's, District 7 had developed a "Program to Upgrade and Control the Los Angeles Freeway Network". This program monitored sections of freeways that needed to be widened due to very heavy traffic demand. It was noted that as projects were completed, freeway congestion disappeared. However, as time went on, congestion returned since many motorists that were formerly taking city streets discovered the faster-moving freeways. Ramp meters were then installed to control the tremendous inflow of traffic into the freeway system and to discourage local short trips.

In 1992, the first connector meter in District 7 was installed on the Southbound Route 5 connector to the Southbound Route 110 Freeway. In 1994, Route 105 (Glenn Anderson Freeway) was opened to traffic. Design and construction of the Route 105 included on-ramp meters and freeway-to-freeway connector meters. Implementation of connector metering was possible on Route 105, due to long and wide connectors providing adequate storage and sufficient sight distance for fast approaching vehicles, especially on heavy volume connectors.

Today, ramp metering represents an important element of the Traffic Management System (TMS). The focal point of the TMS is maximizing traffic flow on the freeway system by reducing congestion. Other elements of the TMS include:

- Freeway Surveillance Equipment – Provides essential traffic data to the LARTMC for early detection of incidents and locates areas of traffic congestion. Freeway surveillance equipment is part of the ramp meter detection system and is installed and maintained by the Ramp Metering Branch, the Intelligent Transportation Systems (ITS) Branch, and the Electrical Maintenance Branch.
- Closed Circuit Television (CCTV) – Cameras with pan, tilt and zoom capabilities are used to confirm the exact location, nature and severity of freeway incidents.
- Changeable Message Signs (CMS) – CMS's are located at strategic points on the freeway system. The LARTMC currently manages 128 CMS's in District 7. This number will most likely increase year over year. The LARTMC updates the display of CMS messages to provide major incident information affecting traffic conditions and severe weather advisories. Estimated travel times are now displayed on selected district-wide CMS's. In the event of child abduction, CMS's are also used by law enforcement to display Amber Alert messages.



Close Circuit TV
(CCTV)

- Highway Advisory Radio (HAR) – A short-range broadcast radio with transmitters located within the freeway right-of-way to provide motorists with updated informational messages such as directional advisories, traffic control restrictions, as well as general information. The LARTMC currently manages 22 HARS in District 7. This number will most likely increase year over year. HAR messages are remotely activated from the LARTMC.
- Freeway Service Patrol (FSP) – FSP is responsible to provide assistance to stranded motorists and quickly repair or remove disabled vehicles to relieve freeway congestion. Typical hours of operations are Monday through Friday between 6:00 AM and 7:00 PM, Saturday and Sunday from 10:00 AM until 6:30 PM.

District 7 is committed to using numerous traffic management strategies to maintain an efficient freeway system by keeping it operating at, or at least near, capacity. Ramp Metering is an integral part of the system management concept that focuses on implementing operational strategies to reduce congestion and increase safety on California's state highway system with the help of advanced technologies.



New LARTMC

The Advanced Transportation Management System (ATMS), located in the Los Angeles Regional Transportation Management Center (LARTMC), has been an important tool for the ramp metering operations. ATMS provides both historical and real-time traffic data for on-ramps, off-ramps, freeway-to-freeway connectors, and freeway mainline. Such data constitutes a vital and is often the primary source in determining the appropriate metering rates that are unique to each and every ramp meter location. In addition, District 7 ramp-metering engineers, using the ATMS display map and field video cameras, can quickly and effectively modify numerous ramp meter parameters including, but not limited to, time of metering. This feature is often used when responding to a scheduled construction project, a major traffic incident, or an emergency lane closure due to an unforeseen event. Thus, the use of ATMS in District 7 results in an increase in traffic flow efficiency by allowing faster response to dynamic field conditions. Furthermore, the Media and various private and public organizations currently use the ATMS real-time traffic data and display map to report traffic conditions via Radio, Television, and the Internet.

Traffic Operations Management Information System (TOMIS)

Traffic Operations Management Information System (TOMIS) is a data reporting system that captures work expenditures for Traffic Operations Program activities. TOMIS enables production of a monthly report comparing workload output (production) to work effort (expenditure). Ramp Metering Branches throughout Caltrans in all 12 districts have

adopted TOMIS. Expenditure Authorizations (EA) and subjobs change from time to time. On a monthly basis, production units for each subjob are reported to Headquarters. Currently, the workload standard for 3RSUR and 3RPNT is 49 and 15 hours per widget, respectively. The workload standards for other subjobs are under development.

Ramp Metering Procedure Manual and Addendum

The 2005 Ramp Metering Procedure Manual and Addendum can currently be found at <http://www.dot.ca.gov/dist07/news/reports/docs/RAMP%20METERING%20PROCEDURE%20MANUAL%20ADDENDUM.pdf>.

Convert Existing Ramp HOV Bypass Lane to a Metered HOV or Mix Flow Lane

As part of Route 210 Congestion Relief project, 26 non-metered HOV by-pass lanes along various on-ramps were converted to metered mix flow lanes, while 10 other HOV by-pass lanes were transformed to metered on-ramp HOV lanes.

Major Ramp Metering Operational Studies

- **I-405 Sepulveda Pass Widening Project**

Ramp metering personnel was involved in preparation of technical specifications and in reviewing design plans at the various stages of this design build project. This 10 mile long project from Route 10 to Route 101 will improve ramps, bridges and sound walls on San Diego freeway. This \$1.03 billion dollar project will reduce commuter time, improve safety, reduce air pollution and improve the links with the state and regional transportation network.

II. RAMP METERING BASICS

Ramp meters are traffic signals placed on freeway entrance ramps or freeway connectors to control the flow of vehicles entering the freeway or moving from one freeway to another. They are designed to decrease congestion and improve the average speed of vehicles traveling on the freeway, by controlling vehicular flow at most inputs onto the mainline.

By installing a traffic signal at the on-ramp, Caltrans can control the rate at which vehicles enter the freeway. Vehicles entering at short intervals are less likely to slow down flowing traffic and can merge onto the freeway without causing the traditional bottlenecks, associated with heavy unmetered on-ramp traffic volumes. In addition, metering has been proven to reduce rear end and sideswipe traffic collisions, especially during congestion periods.



Ramp Meter Signal Lights

The capacity of a freeway, in free-flow conditions, could easily reach 2000 vehicles per hour per lane (v/h/l). However, during congestion periods, this number often drops below 1500 v/h/l. Thus, a free-flowing traffic lane can carry 33% more cars than a congested lane. It is in the public interest to maintain the freeways moving at near capacity; therefore, by dispersing vehicular platoons entering the mainline, ramp metering helps to decrease traffic delays.

Vehicles with two or more occupants may use the High Occupancy Vehicle (HOV) by-pass lane (where available) to access the freeway mainline without stopping at the ramp meter. This practice promotes carpooling that reduces the overall number of vehicles on the freeway. On the other hand, since the freeway traffic demand continues to rise, the need to meter the carpool by-pass lane is anticipated. Currently, District 7 is proposing to meter the existing HOV by-pass lanes, where viable.



Ramp Meter Controller/Cabinet

Additionally, ramp meters are used to discourage short distance travelers from using the freeway, especially, during the congestion periods where many parallel arterial streets can be utilized. Thus, the option to use local arterials might be better than waiting at ramp meters. As a result, mainline traffic congestion will improve due to less freeway demand.

The following documents were prepared by Caltrans as a guide in implementing ramp metering policy throughout the State:

- Deputy Directive DD-35 defines Caltrans' policy on Ramp Metering. See Attachment 2.
- Ramp Metering Policy Procedures, dated August 1997, provides guidelines for implementing the Department's Ramp Metering Policy (DD-35). See Attachment 3.
- Design of Ramp Metering Facilities is governed by the "Ramp Meter Design Manual", also part of Highway Design Manual. Refer to REFERENCES, Item No. 1.

A. RAMP METERING BENEFITS

The effectiveness of ramp meter systems has always been called into question. It is difficult to quantify ramp metering benefits, without conducting a detailed study to compare with and without effects of ramp metering implementation.

In 2000, Minnesota Legislature passed a bill that required the Minnesota Department of Transportation (MnDOT) to study ramp metering effects in their state. Thus, MnDOT, responsible for managing freeway access in the Twin Cities (Minneapolis and St. Paul) metropolitan area, conducted a four-month study aimed towards capturing these benefits. Data was collected during two different time periods; ramp meters were turned on in the first period then turned off in the second. After analyzing the data from both periods, it was concluded that ramp metering was a cost-effective investment. The study revealed the following ramp metering benefits:

- 21% reduction in accidents
- 8% increase in speed
- 22% reduction in travel time
- 16.3% increase in throughput capacity

For detailed information, please refer to REFERENCES, Item No. 11.

B. TYPES OF RAMP METERING

There are three types of ramp meter operations in District 7:

1. Type 1 – Fixed Time/Time of Day (TOD)

2. Type 2 – Local Mainline Responsive (LMR)
3. Type 3 – System Wide Adaptive Ramp Metering (SWARM)

It should be noted that all three types of metering operation could be implemented according to the following two modes:

- One Car per Cycle Metering - One vehicle per cycle per lane is permitted to enter the freeway. Assuming that green time is typically 2 seconds, the remaining cycle is red time, varying from 2 to 18 seconds. In District 7, the typical maximum metering cycle (Red + Green) time does not exceed 10 seconds or 360 vehicles per hour per lane (v/h/l), in order to minimize meter violations and to minimize vehicle back-up onto local city streets.
- Platoon Metering - Two to three vehicles per cycle per lane are permitted to enter the freeway. Theoretically, it is possible to meter up to 1,200 v/h/l for two vehicles per cycle and 1,320 v/h/l for three vehicles per cycle. Typically, platoon metering is used at freeway connectors or high-traffic ramps, where traffic volumes exceed 900 v/h/l. However when feasible, widening is the better option.

1. Fixed Time/Time of Day (TOD) Metering

Fixed time ramp metering is the simplest form of ramp metering that disperses platoons of vehicles entering the freeway. The ramp meter is programmed to operate based on a single or multiple fixed metering rates, for a pre-set metering period, based on historically averaged traffic conditions. Thus, the primary drawback of this metering type is that the cycle length is “fixed” and does not change or respond to real-time freeway mainline traffic conditions. In addition, if the on-ramp gets congested, vehicle backup (Queue) reaches near city street, the Queue loop, usually located at the entrance of the ramp, will be triggered and the meter rate will increase to the maximum rate of 15 vehicles/minute/lane until traffic back-up at the ramp is relieved. Fixed metering rates can be programmed from 180 to 900 v/h/l for single-vehicle metering and 600 to 1320 v/h/l for platoon metering. This practice allows more vehicles to enter the freeway mainline regardless of what the freeway traffic conditions are. Therefore, this type of ramp metering is used only on a limited basis when mainline detection is malfunctioning or during construction.

2. Local Mainline Responsive (LMR) Metering

In addition to all the features of fixed time metering, local mainline traffic-responsive metering is directly influenced by the dynamic traffic conditions at the on-ramp and on the freeway mainline lanes adjacent to the on-ramp. If the traffic volume and occupancy on the mainline freeway drop below a set critical volume and critical occupancy, the ramp meter software would override the programmed meter rates to allow more vehicles to enter onto the freeway; thus relieving traffic congestion on local streets. Local mainline responsive metering is widely used in District 7.

The primary drawback of this type of local mainline responsive metering operation is that it reacts only to local mainline traffic conditions immediately adjacent to the ramp and does

not take into account the conditions of the rest of the freeway corridor. Thus, the need to improve the Local Mainline Responsive (LMR) Metering had brought the concept of System Wide Adaptive Ramp Metering (SWARM).

3. System Wide Adaptive Ramp Metering (SWARM)

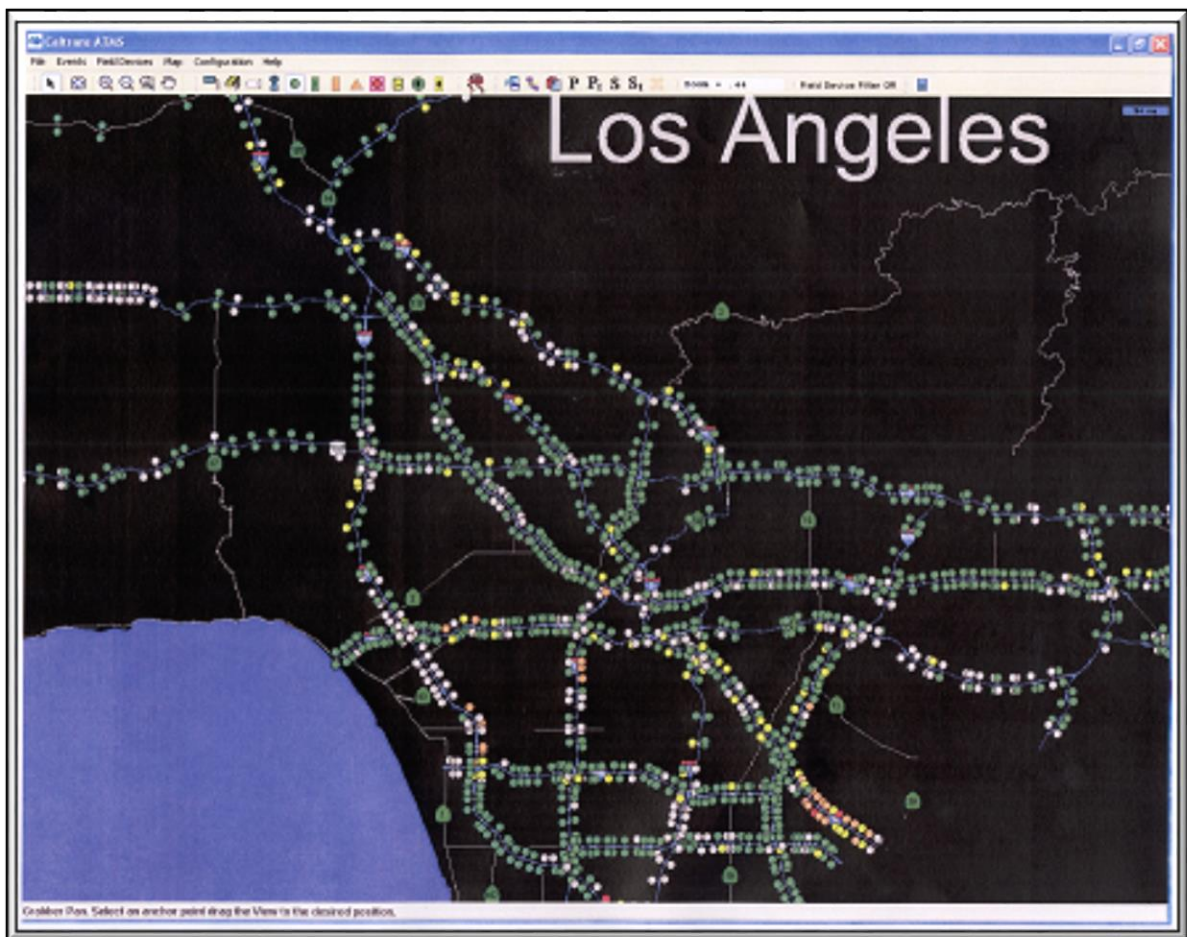
System Wide Adaptive Ramp Metering (SWARM) seeks to optimize traffic flow on the mainline by being responsive to a whole freeway corridor. This type of technology is still under development.

For additional information, please refer to the Section III Subsection B “SYSTEM WIDE ADAPTIVE RAMP METERING” section of this Ramp Metering Annual Report.

III. RAMP METERING TECHNOLOGY DEVELOPMENT

A. ADVANCED TRANSPORTATION MANAGEMENT SYSTEM (ATMS)

The Advanced Transportation Management System (ATMS), located in the new Los Angeles Regional Transportation Management Center (LARTMC), is a computer system that was designed to assist in the collection and dissemination of traffic information in order to effectively manage the existing District 7 Transportation System. Refer to REFERENCES, Items No. 6, 7, and 14 for more detail. The LARTMC was designed with the intention to reduce congestion and increase safety through the rapid detection of, response to, and removal of incidents on the freeway. Using ATMS, Ramp Metering engineers manage recurring congestion by remotely controlling the ramp meter operation and analyzing freeway system efficiency.



ATMS Map Display

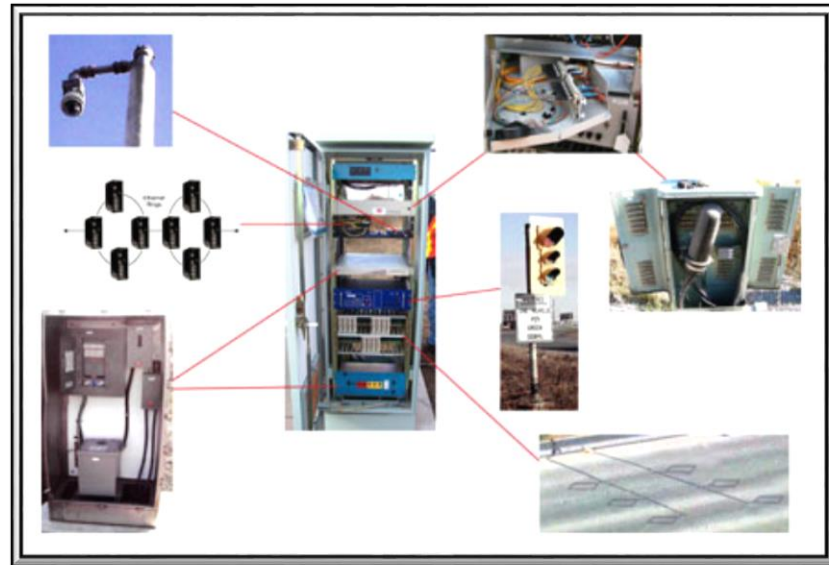
Another ATMS enhanced feature includes incident detection, which is integrated with the closed circuit television (CCTV) cameras to view dynamic traffic conditions, and changeable message signs (CMS) and highway advisory radio (HAR) to inform motorists of existing freeway conditions and estimated travel times.

ATMS gets its data from field hardware. The vehicle loop detector system, located on freeway mainline lanes, on-ramps, off-ramps, connectors, etc., is connected to traffic controllers enabling data to be sent to the ATMS.

Ramp Metering, Intelligent Transportation

Systems (ITS) and

Electrical Maintenance personnel are responsible for new installations as well as maintaining, operating, and upgrading or modifying existing field elements.



ATMS Communications System

In October 2006, Caltrans District 7 Ramp Metering Branch and ITS Branch entered into a contract with Delcan Technologies to modify the existing ATMS software. The goal of the modification was to improve the ATMS to be more user-friendly and to be able to easily deploy the SWARM algorithm.

B. SYSTEM WIDE ADAPTIVE RAMP METERING (SWARM)

System Wide Adaptive Ramp Metering (SWARM) is a ramp meter operating system, developed by National Engineering Technology (NET) Corporation (Currently known as DELCAN TECHNOLOGIES), based on the recommendations and input of District 7 Ramp Metering Branch. This technology is still under development.

SWARM seeks to optimize traffic flow on the mainline by being responsive to actual and future forecasted traffic conditions throughout the system and to recurrent and non-recurrent congestion.

SWARM was originally tested in 2001 and 2002 on Routes 210 and 405. Results of the Route 210 study were published in the "PRELIMINARY SWARM STUDY REPORT" dated November 2001 and the "SWARM STUDY FINAL REPORT" dated October 2002.

A brief summary was prepared following the Route 405 study in 2002. Please refer to REFERENCES, Item Nos. 4, 5 and 16.

In 2008 and 2009, SWARM was tested and implemented along the eastbound and westbound directions of Route 210, from Baseline Road at the Los Angeles / San Bernardino County line (PM 52.00) to Marengo Avenue in the City of Pasadena, just east of the Route 134 Interchange (PM 26.00). This SWARM implementation was the first since the Route 405 study in January 2002 and was part of Route 210 Growth Plan – Congestion Relief Project. Following this study a final report outlining the benefits was published on July 21, 2009. Based on the report recommendation, SWARM was again implemented along the same limits of Rte. 210, between March and August 2013. This time SWARM application was during the hours before and after the AM and PM peak periods, while Local Traffic Responsive (LMR) was implemented during the peaks. However, due to ongoing sudden communication failures and lack of resources for monitoring the progress and benefits of such application, SWARM implementation was suspended at the end of August 2013.

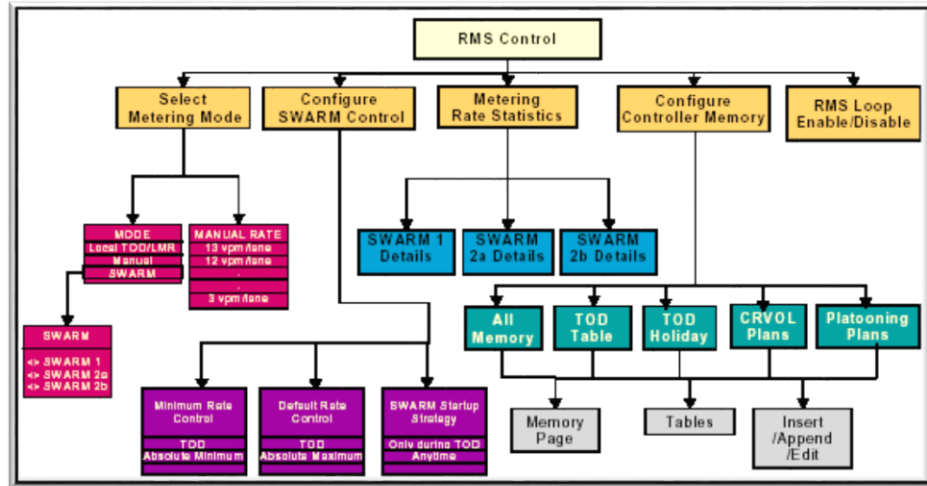
Types of SWARM

Three basic types of SWARM had been developed. SWARM 1 operates system wide to predict congestion. SWARM 2a and SWARM 2b operate locally and are based on headway and storage capacity respectively. The development of SWARM is on-going. Therefore, changes are likely to occur.

1. SWARM 1

SWARM 1 is system wide adaptive and based on a freeway network divided into SWARM sections. Each section begins and ends at a mainline vehicle detection station (VDS) identified as a bottleneck. SWARM 1 algorithm operates at designated and dynamic bottleneck locations and controls vehicle flow of all upstream on-ramp locations linked to that bottleneck.

Since it is directly related to congestion, density is monitored at each bottleneck location. The algorithm requires a nominal saturation density threshold for each mainline VDS in the network.



Ramp Meter Station (RMS) Control Diagram

The algorithm attempts to estimate the density n minutes (user settable) in the future based on real time traffic data. When estimated density, at the bottleneck, exceeds saturation density, ramp meter rates will be computed in an attempt to proactively react to the predicted onset of congestion. Starting at the bottleneck and working upstream, the software calculates new metering rates based on the required volume reductions. Actual metering rates vary between maximum and minimum rates. Since rate adjustments may be positive or negative, excess or reduction values are propagated upstream (user settable).

2. SWARM 2a

SWARM 2a is local responsive based on headway (time between consecutive vehicles). It uses the density function to compute local metering rates and attempts to maintain headway such that the maximum flow can be obtained.

3. SWARM 2b

SWARM 2b is local responsive based on storage. It computes the number of vehicles stored between two VDS stations and compares it to a maximum storage value. Metering rates are computed to maintain level of service (LOS) D as long as possible.

4. SWARM Combinations

SWARM can be used in combinations, i.e., SWARM 1 and 2b. The controller uses the more restrictive rates of those recommended. Within a bottleneck segment, some controllers can be programmed to be on local Time of Day (TOD) mode while others are programmed to be on one of the SWARM modes. The use of the local Time of Day mode is especially useful at on-ramps that are experiencing heavy traffic volumes and cannot be further restricted.

5. Advantages of SWARM

- It predicts future traffic conditions.
- It maximizes traffic flow on the mainline.
- It is responsive to actual traffic conditions throughout the freeway corridor.
- It is responsive to recurring and non-recurring congestion.

6. Disadvantages of SWARM

- Ramp control and traffic surveillance devices must be connected to a central computerized communications center.
- Communication lines have to be operating at all times in order for SWARM to operate properly.
- SWARM requires accurate data from mainline and on and off-ramp detectors in order to work effectively.
- It is more complicated than local traffic responsive metering.
- SWARM software is too big to easily troubleshoot problems.

C. SATMS 3.0

SATMS (Semi-Automatic Traffic Management System) 3.0 is the latest computer processor chip developed by the Caltrans ITS Branch to upgrade the existing ramp metering software. The previous versions were SATMS 1, used only at on-ramps, and SATMS C, used for both connector and on-ramp locations.

The primary goal of the SATMS 3.0 upgrade was to improve the compatibility with the new ramp metering SWARM algorithm. Furthermore, other features were also added in order to enhance the overall ramp meter operation.

In 2002, the SATMS 3.0 chip was tested at several locations in District 7. Once the testing phase was successfully completed, the updated chip was installed at all on-ramp controller cabinets. By the end of 2003, ramp meter operation was universal district wide as the SATMS 3.0 chip replaced the obsolete model.

The new features in the SATMS 3.0 chip are:

- The controller 170 initiation reset time following a power failure to reduce the watchdog black out problem is sped up. Thus, variation or brief interruption in power voltage level will have less effect on the operation of the ramp meter.
- The loss of communication Cycle Time is increased from one cycle (approximately 30 seconds) to ten cycles (around five minutes) in order to minimize frequent changes between SWARM and local Time of Day modes. Thus, communication losses lasting no more than ten cycles would not affect the implementation of SWARM in the field; the controller would meter for up to five minutes, according to the last SWARM rate before communication failure occurred.

- The Queue override maximum rate can be set by a ramp meter engineer to be lower than 15 vehicles per minute per lane. In addition, the new chip provides the ability of linking the activation of the Queue override mode to mainline traffic condition by settable threshold critical speed level (normally 35 mph) to control Queue activation.
- The Queue override mode, created to speed up the metering rate when vehicular back up reaches the entrance of the on-ramp, can be used with the SWARM mode. If activated, the Queue override mode will gradually increase the metering rate, dictated by SWARM, up to the maximum rate of 15 vehicles per minute per lane; thus, reducing the overflow of vehicles onto city streets.
- Whenever metering is initiated or terminated by SWARM or loss of communication cycle time exceeds ten cycles, the controller will apply one-minute “Green” light at the beginning and at the end of each metering phase.
- Set default values for the SATMS 3.0 chip are improved over the older versions.
- The traffic responsive feature is improved.
- Q2 loop operation (for connectors only) is enhanced as follows:
 1. Q2 can be programmed to operate independently of Q1 to trigger “Green” light when backup occurs.
 2. Similarly to on-ramps, the Queue 1 Override maximum rate can be set at a rate lower than 15 vehicles per minute per lane. In addition, the Queue 1 and 2 activation modes can be controlled by mainline threshold critical speed level set by the engineer.

D. STATEWIDE RAMP METERING SOFTWARE

Several ramp metering software packages have been used by different districts within Caltrans. They include the San Diego Ramp Metering System (SDRMS), which was deployed in Districts 3, 6, 8, 10, and 11, the Semi-Automatic Traffic Management System (SATMS), which was deployed in District 7, and the Traffic Operations System (TOS), which was deployed in District 4. District 8 deploys Revision 8 of the SDRMS. District 11 uses a dynamic ramp metering system. A variation of SATMS, named Orange County Ramp Metering System (OCRMS), District 12 allows staggered ramp metering.

E. ROUTE 210 STRATEGIC GROWTH PLAN – CONGESTION RELIEF PROJECT (2009)

Route 210 Congestion Relief Projects primarily focused on the development and implementation of enhanced on-ramp and freeway-to-freeway connector metering strategies designed to improve the ability for effective traffic management along Route 210 corridor.

Route 210 Strategic Growth Plan consists of 2 congestion relief projects. The first project, EA 257404, extends over the eastern segment of Route 210 corridor from post mile 26.00 (City of Pasadena) to post mile 52.00 (San Bernardino County Line), while the second, EA 258004, covers the western segment from post mile 0.31 (Route 5) to post mile 24.92 (Route 134).

The deployment and testing of these strategies should provide the opportunity to evaluate the potential impacts of different aspects of the improvements. These main aspects are highlighted below:

1. The installation of 41 new traffic responsive ramp meters at existing non-metered on-ramp locations, bringing the total to 107 ramp metering stations throughout the corridor.
2. Addition of 24 microwave vehicle detection stations, along brief remote sections in the western end of Route 210 corridor: This new technology was installed within a rural section along the western segment of the corridor.
3. Installation of 9 freeway-to-freeway connector meters along five major interchanges (Routes 2, 57, 118, 134 and 605 with Route 210 corridor): The purpose of this strategy is to regulate the flow of vehicles, from connecting freeways, onto Route 210.
4. Introducing High Occupancy Vehicle (HOV) bypass lane metering at 9 existing and 20 new ramp metering locations. This strategy is intended to better manage the previously uncontrolled flow of HOV vehicles onto the Freeway mainline.
5. Conversion of 23 existing non-metered HOV by-pass lane to metered on-ramp mix flow lanes: This conversion was required in order to provide additional vehicular storage capacity needed to effectively implement ramp metering operation.
6. System Wide Adaptive Ramp Metering (SWARM): This advanced metering strategy works by evaluating real-time traffic situations at dynamic bottlenecks throughout the corridor, in order to predict future congestion and properly set upstream ramp metering rates helping to reduce congestion. This methodology improves the ability to maximize and maintain efficiency of traffic flow throughout the corridor. It represents an innovation over current metering capabilities, by implementing ramp metering on a system wide basis, thus, responding to both recurring and non-recurring traffic congestion.

The addition of these strategies also required many supporting implementations including the addition of signage (both extinguishable and static), re-striping, the addition or repositioning of traffic detectors, and ramp reconfiguration.

Early in 2008, and following the completion of Construction in 2007, all ramp meters along the eastern segment of Route 210, in addition to four connector meters, between Route 210

and Routes 57 and 605 within the same limits of the corridor, were activated. Traffic data was collected, analyzed and compared to the before condition in 2006. The evaluation revealed positive impact due to the ramp and connector metering installation. A detailed report highlighting the overall benefits and detailing all the positive improvements was released on July 31, 2009.

In June 2009, all ramp meters along the western segment of Route 210 corridor were activated; however the five connector meters from Routes 2, 118 and 134 onto Route 210, remain inactive awaiting a detailed traffic study and observation of the overall traffic condition in the area.

IV. RESPONSIBILITIES

Ramp Metering Branch, Intelligent Transportation System (ITS), and Electrical Maintenance Branch work as a team in respect to ramp metering issues and development. Ramp Metering Branch is responsible for the operation of ramp meters district-wide. ITS Branch provides technical support for the LARTMC. Electrical Maintenance Branch is responsible for the maintenance of hardware and electrical equipment deployed in the field. To maintain and to improve the cooperation, these groups meet on a quarterly basis.

A. RAMP METERING BRANCH

The ramp metering system in the District is inspected and regularly observed through routine field surveillance and frequent ATMS observation. Ramp Metering Engineers are responsible for the ramp meter programmed software as well as the proper operation of ramp meters district-wide. Ramp Metering operation software consists of a “RAM (Random Access Memory) Map” package which includes a program sheet, time of day (TOD) table and a detailed loop detector (sensor) diagram layout, in addition to an electrical as-built plan showing all of the hardware. Ramp Meter hardware includes signals, controllers, loop detectors, signing, striping and advance warning devices. Area Engineers (lead workers) are assigned ramp meters by routes or segments of routes. Other engineers within the Ramp Metering Branch assist the Area Engineers.

B. ELECTRICAL MAINTENANCE BRANCH

Electrical Maintenance responds to ramp meter malfunctions reported by CHP, Ramp Metering Branch, ITS Branch and the general public, if related to hardware and electrical problems. Electrical Maintenance performs routine checks of all ramp-metering equipment. The following main actions are performed by the Electrical Maintenance technician during this check:

- Maintenance of Freeway Meter Signals

Meter signals should be checked for damage, proper operation, and timing every 120 days. This check should include the following items as a minimum:

(A) Field Inspection

- (1) Visual check of indications.
- (2) Signal indication alignment.
- (3) Hardware (signs, poles, back plates, etc.).
- (4) Pull box covers (broken, missing, and clear of dirt or debris).
- (5) Visual check of service cabinet and equipment locks.

- (6) Visual check of loops in roadway (if possible).

(B) Cabinet Interior

- (1) Controller unit indicator lights and display.
- (2) Function and timing.
- (3) Detector indicator lights and operation.
- (4) Check output devices, including interconnect systems.
- (5) Thermostat and ventilation system including filter.
- (6) Clean cabinet and interior components.
- (7) Check documentation (timing sheets, schematics, wiring plans, etc, and inspection noted on cabinet login card).

(C) Cabinet Exterior

- (1) Condition of surface (paint, damage, graffiti).
- (2) Condition of locks and handles.
- (3) Operation of Police panel switches.

▪ Meter Timing and Operation

Initial timing of ramp meter signals and any subsequent changes in timing are the sole responsibility of the Ramp Metering Branch.

Maintaining the meters is the responsibility of the Electrical Maintenance Branch.

C. INTELLIGENT TRANSPORTATION SYSTEMS (ITS) BRANCH

ITS Branch provides technical support for the LARTMC. This includes ramp metering and ATMS. ITS main duties are:

1. Test and develop new software related to metering operation.
2. Set up the configuration of ATMS.
3. Review electrical design plans for new projects.
4. Monitor and correct any discrepancies found on the ATMS data reports such as icons, loop configuration, etc.
5. Check system electrical operation and final compliance in accordance to the contract documents or as-built plans on all new and replacement equipment.
6. Test and maintain communication lines between field equipment and LARTMC.

D. RAMP METERING WORKLOAD TRACKING SYSTEM

The Office of System Management Operations tracks the activities of Ramp Metering staff throughout the State. It is the responsibility of each District to provide charging activities to the Office of System Management Operations.

A spreadsheet for tracking ramp metering surveillance widgets was created by Ramp Metering Statewide Committee. A workload standard is defined as the number of hours

spent per widget production. The ramp metering workload standard was developed following three basic steps. First, the statewide team focused on developing a comprehensive ramp metering activity list. This list provides a basic understanding of what the ramp metering program does and what the discrepancies are among the districts. The activities were further categorized into three categories, namely Critical, Essential, and Preventive. Critical activities are defined as the must-do activities to operate ramp meters; essential activities are those to reduce operational problems; while activities to prevent operational problems are defined as preventive.

After the activities were listed and agreed upon, the group decided to aggregate them into three widgets and each widget into subtask. District 7 Ramp Metering Branch is committed to implementing the workload tracking practice. The following is General information, definitions and instructions on using ramp metering workload tracking spreadsheet. (Please see Attachment 6 for sample of spreadsheet report).

General information and instructions on using this spreadsheet for tracking ramp metering surveillance widgets:

1. There were 6 "main" ramp metering surveillance tasks that can be performed per the BPAC briefing package for ramp metering as summarized on the right. Each main task is weighted equally and is considered to be 1/6 of a ramp metering surveillance widget. Each main task has several "sub" tasks that when all performed, constitute the main task being completed. Each sub task is weighted according to the number of sub tasks within a given main task. For example, each sub task under Task 1 is weighted 1/8 of the task since there are 8 sub tasks within it; each sub task in Task 2 is weighted 1/10 of the task since there are 10 sub tasks within it, etc.
2. Each month has its own tab in the spreadsheet and contains each ramp meter location with boxes to track which ramp metering surveillance sub tasks have been performed for each location during the month. Each time a sub task is performed for a particular location, the individual completing the task enters it into the spreadsheet.
3. Tasks performed are tracked by ramp meter location NOT by individual(s) performing the task. In other words, if two or more people are working together on a sub task at a particular location, the sub task should be tallied only once in the spreadsheet. A particular sub task can, however, be performed multiple times at a given location in a given month, and can be counted as many times as it is completed, but again, is not multiplied by the number of individuals working on the sub task together. For example, occupancy counts can be collected (task #2, sub task #1) at a particular ramp meter location by two people 4 times in a month. On the spreadsheet, it would be reported as 4 instances of a sub task in task #2 being completed, not 8 instances (4 x 2 individuals).
4. By tallying the number of sub tasks performed in the spreadsheet, the equivalent number of widgets (shown highlighted in yellow) to be reported to HQ each month is automatically calculated based on the parameters outlined in item 1 above.

TASK DEFINITIONS (PER BPAC BRIEFING PACKAGE FOR RAMP METERING DATED 2/16/10)

• TASK 1: CONDUCT FIELD/OFFICE ELEMENT SURVEILLANCE

- Monitor ramp meter functionality in the field
- Monitor ramp meter functionality through a central system in the office
- Review and adjust corridor ramp metering hours (am, pm, or all day for both weekdays and weekends).
- Inspect firmware (SATMS/SDRMS/TOS) and hardware in the field.
- Report hardware or communication problems to appropriate functional units such as TMC support, electrical maintenance and TMS support.
- Investigate and respond to inquiries/complaints
- Respond to inquiries (internal and external)
- Respond to legal claims inquiries

• TASK 2: COLLECT TRAFFIC DATA

- Occupancy counts
- Queue and demand
- ramp geometry
- ramp volumes
- Mainline volumes
- Turning movements at the ramp termini
- meter violation rates
- HOV (Bypass) counts
- HOV (Bypass) Violation rates
- Maintain and update log of surveillance results

• TASK 3: ANALYZE TRAFFIC DATA

- Analyze traffic data
- HOV (Bypass) analysis
- Corridor analysis
- Analyze violation rates
- Develop recommendations and implementation plans
- Conduct before and after studies

• TASK 4: ADJUST FIELD ELEMENTS

- Adjust ramp meter equipment such as detector settings.
- Adjust metering parameters (rate, traffic responsive thresholds, holiday timing plans, etc.)
- Fine tune field elements and metering rates, if necessary
- Maintain log of ramp metering changes (including meter timing)

- Efforts and coordination with Maintenance and other internal/external offices To restore the knock-downs

• **TASK 5: SUPPORT OPERATIONAL IMPROVEMENT**

- Obtain data from ATMS, RMIS or other sources
- Develop ramp meter operational study for each freeway
- Develop plans for operational improvement
- Generate the improvement report
- Support ramp metering operations during construction
- Implement and evaluate the improvement
- Respond to inquiries (internal and external)
- Participate in specification development and procurement process

• **TASK 6: CONDUCT YEARLY INVENTORY**

- Conduct inventory of each RMS and VDS/TMS
- Report findings to TMC support and/or electrical maintenance, Headquarters

V. REFERENCES

For further information about ramp metering and ramp metering related subjects, you can refer to the following manuals and reports:

1. "Ramp Meter Design Manual", Caltrans, January 2000.
2. "Ramp Meter Development Plan", Reza Akramian & Rody Torchin, January 2009.
3. Amended "Ramp Metering Procedure Manual", Rafael Benitez-Lopez, November 2005.
4. "Preliminary SWARM Study Report", Hanh Pham, Caltrans District 7, November 2001.
5. "SWARM Study Final Report", Hanh Pham, Caltrans District 7, October 2002.
6. "ATMS User's Manual", National Engineering Technology Corporation, June 2000.
7. "ATMS Traffic Engineer's Manual", National Engineering Technology Corporation, June 2000.
8. "Highway Capacity Manual", Transportation Research Board, 2000.
9. "Traffic Manual", Caltrans
10. "Highway Design Manual", Caltrans
11. "Twin Cities Ramp Meter Evaluation", Cambridge Systematics Inc., November 27 2001.
12. "Traffic Bulletin No. 4 - Notes on Freeway Capacity", Karl Moskowitz and Leonard Newman, July 1962.
13. "Traffic Bulletin No. 16 – Introduction to Capacity", Leonard Newman, April 1969.
14. "Ramp Meter Operation Plan", National Engineering Technology Corporation, December 2001.
15. "Basic Ramp Control", M.K. Kim, Caltrans
16. Route 405 SWARM Study Summary, Wahib Jreij & Fady Al-Awar, Caltrans District 7, January 2003.
17. 2002 "System Wide Adaptive Ramp Metering" (SWARM) Study Final Report
http://www.dot.ca.gov/dist07/news/reports/docs/swarm_LA210_final.pdf

VI. ATTACHMENTS

ROUTE RESPONSIBILITIES
Afsaneh Razavi (Ramp Metering Branch Chief)
Phone (323) 259-1841

AREA ENGINEER: Wahib Jreij

Phone: (323) 259 -1842

<u>Co/Rte</u>	<u>PM Limits</u>	<u>Limits</u>	<u>Assigned</u>	<u>Ph. Ext</u>	<u>Meters</u>
LA-10	18.39/48.30	Route 101 to San Bernardino County	Jreij / Dumaplin	1842	81
LA-57	0.00/12.00	Orange County to Route 210	Jreij / Dumaplin	1846	20
LA-60	0.00/30.50	East LA Inter. to San Bernardino Co.	Jreij / Dumaplin	1846	65
LA-71	0.30/4.80	San Bernardino County to Route 10	Jreij / Dumaplin	1846	3
LA-210	0.00/52.00	Route 5 to San Bernardino County	Jreij / Dumaplin	1842	108
LA-210	Connector	NB Rte 57 to EB Rte 210	Jreij / Dumaplin	1842	1
LA-210	Connector	NB Rte 57 to WB Rte 210	Jreij / Dumaplin	1842	1
LA-210	Connector	NB Rte 605 to EB Rte 210	Jreij / Dumaplin	1842	1
LA-210	Connector	NB Rte 605 to WB Rte 210	Jreij / Dumaplin	1842	1
LA-210	Connector	EB Rte 118 to EB Rte 210	Jreij / Dumaplin	1842	1
LA-210	Connector	EB Rte 118 to WB Rte 210	Jreij / Dumaplin	1842	1
LA-210	Connector	NB Rte 2 to EB Rte 210	Jreij / Dumaplin	1842	1
LA-210	Connector	NB Rte 2 to WB Rte 210	Jreij / Dumaplin	1842	1
LA-210	Connector	EB Rte 134 to WB Rte 210	Jreij / Dumaplin	1842	1
Total					286

AREA ENGINEER: Iqbal Toorawa

Phone: (323) 259 -1858

<u>Co/Rte</u>	<u>PM Limits</u>	<u>Limits</u>	<u>Assigned</u>	<u>Ph. Ext</u>	<u>Meters</u>
LA-91	6.01/20.74	Vermont to Orange County	Toorawa	1858	41
LA-110	0.00/20.36	Route 47 to Rte 05	Toorawa / Torchin	1859	45
LA-110	20.36/31.91	Route 05 to Glenarm St. (Pasadena)	Toorawa	1858	0
LA-110	Connector	S/B 5 to S/B 110	Toorawa	1858	1
LA-605	0.00/26.00	Orange County to Route 210	Toorawa/Masatsugu	1855	56
Total					143

AREA ENGINEER: Rafael Benitez

Phone: (323) 259 -1856

LA-10	1.88/18.33	PCH to East LA Interchange	Benitez	1856	46
LA-105	0.00/18.14	Sepulveda (LAX) to Rte 605	Benitez	1856	28
LA-105	Connector	N/B 405 to E/B 105	Benitez	1856	1
LA-105	Connector	S/B 405 to E/B 105	Benitez	1856	1
LA-105	Connector	N/B 110 to E/B 105	Benitez	1856	1
LA-105	Connector	S/B 110 to W/B 105	Benitez	1856	1
LA-105	Connector	S/B 110 to E/B 105	Benitez	1856	1
LA-105	Connector	N/B 710 to W/B 105	Benitez	1856	1
LA-105	Connector	N/B 710 to E/B 105	Benitez	1856	1
LA-105	Connector	S/B 710 to E/B 105	Benitez	1856	1
LA-105	Connector	S/B 710 to W/B 105	Benitez	1856	1
LA-110	Connector	(E/W)/B 105 to N/B 110	Benitez	1856	1
LA-110	Connector	E/B 105 to S/B 110	Benitez	1856	1
LA-110	Connector	W/B 105 to S/B 110	Benitez	1856	1
LA-405	Connector	E/W 105 to S/B 405	Benitez	1856	1
LA-405	Connector	W/B 105 to N/B 405	Benitez	1856	1
LA-605	Connector	E/B 105 to N/B 605	Benitez	1856	1
LA-605	Connector	E/B 105 to S/B 605	Benitez	1856	1
LA-710	Connector	E/W 105 to S/B 710	Benitez	1856	1
LA-710	Connector	E/W 105 to N/B 710	Benitez	1856	1
				Total	92

AREA ENGINEER: Jeff Le

Phone: (323) 259 -1850

<u>Co/Rte</u>	<u>PM Limits</u>	<u>Limits</u>	<u>Assigned</u>	<u>Ph. Ext</u>	<u>Meters</u>
LA-2	14.08/23.44	Glendale Blvd to Route 210	Le / Atefyekta	1857	7
LA-134	0.0/13.34	Route 170 to Route 210	Le / Atefyekta	1850	30
LA-170	14.57/20.55	Route 101 to Route 5	Le	1850	9
				Total	46

AREA ENGINEER: Hamid Kalkatechi

Phone: (323) 259 -1843

<u>Co/Rte</u>	<u>PM Limits</u>	<u>Limits</u>	<u>Assigned</u>	<u>Ph. Ext</u>	<u>Meters</u>
LA-5	0.00/88.61	Orange County to Kern County	Kalkatechi	1843	99
LA-101	11.60/16.98	Rte 101/134/170 Int. to Rte 101/405 Int.	Kalkatechi	1843	11
LA-138	0.00/1.80	Route 5 to Gorman Post	Kalkatechi	1843	0
				Total	110

AREA ENGINEER: Fady Al-Awar

Phone: (323) 259 -1844

<u>Co/Rte</u>	<u>PM Limits</u>	<u>Limits</u>	<u>Assigned</u>	<u>Ph. Ext</u>	<u>Meters</u>
LA-14	24.79/77.01	Route 5 to Kern County	Al-Awar	1844	0
LA-90	0.92/3.28	Route 1 to Slauson Ave	Al-Awar / Torchin	1859	0
LA-101	0.18/11.60	Mission Rd to 101/134/170 Inter.	Al-Awar	1844	32
LA-118	0.00/14.08	Ventura County to Route 210	Al-Awar	1844	20
Ven-118	18.20/32.60	Route 23 to Los Angeles County	Al-Awar	1844	34
LA-405	48.64/39.40	Route 05 to Route 101	Al-Awar	1844	19
LA-405	39.40/21.44	Route 101 to Route 105	Al-Awar / Torchin	1859	41
Total					146

AREA ENGINEER: Nabil Eskander

Phone: (323) 259 - 1869

<u>Co/Rte</u>	<u>PM Limits</u>	<u>Limits</u>	<u>Assigned</u>	<u>Ph. Ext</u>	<u>Meters</u>
LA-405	0.00/12.95	Orange County to Route 110	Eskander/Atefyekta	1857	37
LA-405	12.95/21.44	Route 110 to Route 105	Eskander / Torchin	1859	23
LA-710	6.80/27.38	Shoreline Dr to Valley Blvd	Eskander/Masatsugu	1869	36
Total					96

AREA ENGINEER: Behdad Sepanj

Phone: (323) 259 - 6306

<u>Co/Rte</u>	<u>PM Limits</u>	<u>Limits</u>	<u>Assigned</u>	<u>Ph. Ext</u>	<u>Meters</u>
Ven-23	3.20/11.60	Route 101 to Route 118	Al-Awar / Sepanj	6303	23
LA-101	16.98/38.19	Rte 101/405 int. to Ventura County	Sepanj	6306	44
Ven-101	0.00/43.62	L.A. County to Santa Barbara Co.	Sepanj	6306	13
Ven-126	0.00/13.24	Route 101 to Hallock Drive	Sepanj	1843	0
Ven-33	0.00/5.66	Route 101 to Casitas Vista Road	Sepanj	1843	0
Total					80

Total number of Meters in District 07 **999**

California Department of Transportation
DEPUTY DIRECTIVE

Number: DD-35

Refer to
Director's Policy: 08-Freeway System
Management

Effective Date: 1-3-95

Supersedes: P&P 91-01

Title: Ramp Metering

POLICY

Caltrans is committed to using ramp metering as an effective traffic management strategy to maintain an efficient freeway system and protect the investment made in constructing freeways to keeping them operating at or near capacity flow rates.

DEFINITION/BACKGROUND

Ramp metering is the common method of ramp entry control. It has been an effective tool in reducing congestion on California freeways since the late 1960s. Caltrans has installed over 1300 ramp meters throughout the state and proposes their installation on all urban freeway entrance ramps where metering will improve or maintain effective operations along freeway corridors.

RESPONSIBILITIES

The Traffic Operations Program Manager is responsible for the development, review and dissemination of policies, guidelines, and procedures for ramp metering (see Ramp Metering Policy Procedures).

The State and Local Project Development Program Manager is responsible for the development and review of geometric design standards for ramp metering and supports the inclusion of ramp metering in projects within freeway segments identified in the Ramp Meter Development Plan.

District Directors are responsible for developing local agency support for ramp metering; implementing ramp metering policies and procedures; and providing justification for deviation from established policy and procedures.

APPLICABILITY

Any employees involved with ramp metering activities.

ORIGINAL SIGNED BY

LEE F. DETER

Deputy Director

Maintenance and Operations

RAMP METERING POLICY PROCEDURES

RAMP METERING POLICY PROCEDURES

I. PURPOSE

The purpose of these procedures is to provide guidelines for implementing the Department's ramp metering policy (DD-35).

II. BACKGROUND

Metering has proven to be an effective traffic operations tool to maximize the efficiency of a corridor. The primary objective of metering is to reduce congestion and the overall travel time of the total traffic stream - on both freeway and surface streets. Ramp metering reduces congestion by:

- Maintaining more consistent freeway throughput.
- Utilizing the capacity of the freeway corridor more efficiently.
- Providing incentives for increased use of carpools, vanpools, and public transit by including preferential lanes, which offer time savings to High Occupancy Vehicles (HOV) at ramp meters.

Secondary benefits include the reduction of congestion-related accidents and air pollution. Ramp meters operate most effectively when upstream mainline traffic is controlled. This control can be accomplished by installing additional ramp meters, metering freeway to freeway connectors or mainline control. These procedures focus on the implementation of ramp metering systems through a coordinated effort involving Caltrans planners, designers, operations personnel, local agency staff, the California Highway Patrol (CHP), and the public.

III. PROCEDURES

- A. It is the District's responsibility to maintain an acceptable level of service on the freeway system, to make the most effective use of each transportation corridor, and to protect the public's investment in the system.

Each District that currently operates, or expects to operate, ramp meters within the next ten years shall prepare a Ramp Meter Development Plan (RMDP) identifying the

freeway segments, including freeway to freeway connectors, which are expected to be metered within this period. The RMDP should also identify freeway segments where upstream mainline control is necessary to maintain effective overall freeway operations. The RMDP shall be updated biennially and be included in local Congestion Management Plans.

- B. Projects, which propose the modification of an existing interchange or the construction of a new interchange within the freeway segments identified in the RMDP, regardless of funding source, should include provisions for ramp meters. This applies to all projects that have an approved Project Study Report dated July 1991 or later (the date of the original Policy and Procedure). These provisions, as defined in the Ramp Meter Design Guidelines, should include right of way, geometric to accommodate vehicle storage and HOV bypass lanes, ramp meter equipment, and CHP enforcement areas. Projects which propose additional capacity within freeway segments identified in the RMDP shall include provisions for ramp meters and shall implement the ramp meters at all entrance ramps within the project limits. In freeway segments identified in the RMDP where mainline control is necessary to maintain effective overall freeway operation, additional freeway capacity should not be constructed without an analysis of the operational impacts to downstream segments. Districts are responsible for performing appropriate environmental studies for ramp metering projects.
- C. The District will work in partnership with metropolitan planning organizations; regional transportation planning agencies, and congestion management agencies to program ramp metering projects and develop implementation plans. Coordination and consultation should be documented and concurrence may be obtained in any form the District considers appropriate.
- D. The Ramp Meter Design Guidelines prepared by the Division of Traffic Operations, in cooperation with the Division of State and Local Project Development, and the CHP shall be used when designing ramp metering facilities. This document is a compilation of design information and operational practices used statewide.
- E. HOV preferential lanes shall be considered wherever ramp meters are installed. The need for HOV bypass lanes should be included in the Project Study Report, Project Information Report, Project Report, and Environmental Document. If an HOV preferential lane is not included in a proposal to ramp meter, the reasons should be addressed in the appropriate document.

The District is responsible for consulting with the CHP on project features, which affect enforcement activities such as HOV lane violations, enforcement pads, etc. Coordination and consultation should be documented.

- F. When selecting the appropriate metering method for the HOV preferential lane, the following criteria should be used:

Control: An analysis of HOV traffic volumes shall be made to determine the impact on mainline traffic flows. Where adverse impacts exist, consideration should include metering the HOV preferential lane and/or more restrictive metering of the SOV lane(s). Consideration should be given to metering the HOV preferential lane if platoons from local signalized intersections adversely affect the operation of the freeway. Storage capacity and effects to local arterials should also be addressed.

Merge Conditions: Prior to entering the freeway, all vehicles on the on-ramp should be provided with adequate space to safely merge with each other. The safest merge condition is when the speeds of the merging vehicles are identical. When the speed differentials between HOVs and SOVs are excessive, consideration should be given to metering the HOV lane. All ramps should be designed in accordance with the Ramp Meter Design Guidelines, which detail adequate merging distances.

Enforcement: The ability to safely enforce occupancy violations of HOV lanes is essential. The CHP should be consulted for their recommendation of enforcement operations at each HOV preferential lane location.

Corridor Operations: In corridors where ramp meters are already operational, the existing metering method may be used as criteria for additional installations in the same corridor. If alternate metering methods are proposed along a corridor, local agencies should be consulted.

The criteria listed above can be applied to new and existing ramp meter installations. If it is being applied to an existing ramp meter, the following criteria should also be used:

Accident History: The accident history of the ramp needs to be investigated. If either the ramp or any portion of the freeway within 500 feet of the ramp gore has been flagged as a high accident concentration location (Table C), each accident report should be reviewed in detail to determine whether or not the HOV operation during the metered period was a contributing factor. If evidence suggests that it could have been a contributing factor to the accident, consideration should be given to metering the HOV preferential lane.

- G. Districts shall provide justification for deviation from the policy and these procedures and concurrence shall be obtained from the Headquarters Traffic Operations District Liaison. Deviations from design standards require the approval of the Project Development Coordinator in the Office of Project Planning and Design.
- H. The Division of Traffic Operations provides District personnel with technical assistance and support on the design and operation of ramp meter systems and assists in the preparation of the District's RMDP.

CONTENTS OF EXCEPTION TO RAMP METERING POLICY FACT SHEET

PROJECT DESCRIPTION

Briefly describe the project. Note the type of project and/or major elements of work to be done.

RAMP METERING POLICY NON-COMPLIANCE FEATURES

Describe the proposed or existing ramp metering policy non-compliance feature(s). (Note: Deviations from advisory or mandatory design standards shall be addressed as required by the *Project Development Procedures Manual*, the *Highway Design Manual* and applicable District Directives.) Design exceptions to standards to be attached to Ramp Meter Policy Fact Sheet.

REASON FOR THE EXCEPTION

Be thorough but brief. Supportive factors may include right-of-way or space constraints, environmental concerns, inordinate costs, etc. Show an estimate of the added cost above the proposed project cost that would be required to conform to the ramp metering policy for which exception is being documented. The estimate does not have to be highly developed but must be realistic.

FUTURE CONSTRUCTION

Describe any planned future projects in the immediate vicinity of the requested ramp meter exception, but do not make any commitments (e.g., ramp metering as part of future projects) unless there is a certainty that they can be followed through.

PROPOSED EXCEPTION REVIEWS AND CONCURRENCE

Note reviews by HQ Traffic Operations, the District Liaison and District Office of Traffic Systems. Give dates of reviews and discuss any comments that were made and their disposition.

REMARKS

Note clarifying remarks. Discuss impacts on project delivery schedule and project costs, if any. Discuss impacts of ramp metering policy non-compliance features.

ATTACHMENTS

Provide a locations map and/or vicinity map for the project, indicating the location of the requested exception(s) to the ramp metering policy. Also provide cross-sections and/or special details as necessary to illustrate the policy non-compliance condition. Letters, resolutions, traffic studies, etc., which help to clarify the reasons for the exception request, may be attached.

SIGNATURE SHEET

The Fact Sheet signature page shall conform to the attached.

Dist-Co-Rte-KP
Source Unit – EA
Project Cost

FACT SHEET

**EXCEPTION TO
RAMP METERING POLICY**

(Insert Registered C.E. Seal)

Prepared by:

(Name), Registered C.E.

Date

Telephone

Approval recommended by:

(Name), Project Manager

Date

Telephone

Concurrence by:

(Name), District Liaison
HQ Traffic Operations

Date

Telephone

Approved by:

(Name), District Division Chief,
Operations

Date

Memorandum

To: DISTRICT DIVISION CHIEFS – Operations **Date:** July 31, 2000
DISTRICT DIVISION CHIEFS – Design
DISTRICT DIVISION CHIEFS – Planning **File:**

From: DEPARTMENT OF TRANSPORTATION
Traffic Operations
Mail Station 36

Subject: Ramp Metering Policy on High Occupancy Vehicle (HOV) Preferential Lanes

The purpose of this memorandum is to clarify and re-affirm the California Department of Transportation (Caltrans) policy on HOV preferential lanes at ramp meter locations. Caltrans is committed to its current policy: **An HOV preferential lane shall be provided at all ramp meter locations.**

The January 2000 edition of the Ramp Meter Design Manual now addresses the circumstances under which exceptions to this policy may be warranted. See ‘Modifications to Existing HOV Preferential Lanes’ located in Section ‘I’ of Chapter One:

- Underutilization of an existing lane plus the need for additional right-of-way for storage
- The availability of an alternate HOV entrance ramp within 2 Km
- The availability of a direct HOV access (drop) ramp

Exceptions shall be handled on a location-by-location basis. Conversions may require Federal Highway Administration actions or concurrence. The District Division Chief for Operations, in consultation with the Headquarters Traffic Operations Liaison, is responsible for approving and documenting decisions to remove HOV preferential lanes. These policies and exceptions also apply to new and reconstruction projects. Districts should refer to the “Exception to Ramp Metering Policy” located in the Appendix of the Ramp Meter Design Manual or contact your Headquarters Traffic Operations Liaison for assistance.

Original Signed By

KIM NYSTROM
Program Manager
Traffic Operations

cc: Mr. Robert Buckley
Program Manager
Design and Local Programs

Ms. Joan Sollenberger
Program Manager
Transportation Planning

RAMP METERING TRACKING SYSTEM

Example of a portion the spreadsheet for tracking ramp metering surveillance widgets:

DISTRICT 7					OCTOBER 2013					
# RAMP METERING SURVEILLANCE WIDGETS TO REPORT TO HQ:									90.1	
WEIGHTED # OF MAIN TASKS COMPLETED:					393.3	11.8	0.2	99.2	34.4	2.0
# OF SUB TASKS COMPLETED:					3146	118.0	1.0	496.0	275	4.0
RAMP METERING SURVEILLANCE SUB TASK COMPLETION LOG										
<i>each time a sub task is completed at a location, add 1 to the applicable main task</i>										
ROUTE 405										
County	Postmile	Direction	Location	Ramp Type	Tasks					
					1	2	3	4	5	6
LA	47.62	S	Rinaldi St	Diamond	2	0	0	3	0	0
LA	47.28	S	San Fernando Mission Rd	Loop	2	0	0	2	0	0
LA	46.28	S	Devonshire St WB	Hook	3	0	0	3	0	0
LA	46.10	S	Devonshire St EB	Diamond	2	0	0	2	0	0
LA	44.62	S	Nordoff St	Hook	3	0	0	2	3	0
LA	43.61	S	Roscoe Blvd	Hook	2	0	0	3	1	0
LA	42.40	S	Sherman Way WB	Loop	3	0	0	3	2	0
LA	42.25	S	Sherman Way EB	Hook	1	0	0	4	1	0
LA	41.48	S	Victory Blvd WB	Hook	2	0	0	2	2	0
LA	41.31	S	Victory Blvd EB	Loop	2	0	0	2	3	0
LA	40.08	S	Burbank Blvd	Hook	3	0	0	3	2	0
LA	39.09	S	Ventura Bl.	Loop	3	0	0	2	1	0
LA	38.42	S	Valley Vista Bl.	Angle	5	0	0	3	2	0
LA	36.25	S	Skirball/Muholland Dr.	Angle	3	0	0	2	3	0
LA	34.73	S	Getty Center Dr.	Angle	4	0	0	1	2	0
LA	33.05	S	Sunset WB/Church Ln	Loop	6	0	0	3	1	0
LA	32.90	S	Sunset Bl. EB	Angle	7	0	0	4	2	0
LA	31.66	S	Wilshire Bl. WB	Loop	7	0	0	6	3	0
LA	31.39	S	Wilshire Bl. EB	Hook	9	0	0	3	3	0
LA	30.80	S	Santa Monica Bl.	Angle	5	0	0	3	2	0
LA	29.16	S	National Bl.	Angle	7	0	0	1	1	0
LA	27.81	S	Venice Bl.	Hook	8	0	0	2	2	0